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Government Concerned About Big Power Shortfall

40100080b Beijing CHINA DAILY (BUSINESS WEEKLY) in English 26 Apr 93 p 1

[Article by Wen Min]

[Text] Five Chinese ministries and commissions issued a notice to local authorities recently asking them to ensure that the country's power industry installs enough generators this year.

The growth of power production, which was 10.7 percent in 1992, should be parallel with that of the national economy, the notice said.

China's industrial production grew by more than 20 percent in 1992 and a further high growth rate is expected.

The units issuing the notices included the State Planning Commission and the State Council's Economic and Trade Office.

Fifty-seven large and medium-size generators capable of producing 11.5 million kilowatts per hour are to be installed this year.

Of them, 44 are thermal ones generating 8.6 million kilowatts per hour and the rest are hydropower ones producing 2.85 million kilowatts per hour.

Also, if possible, another 10 generators producing 2.52 million kilowatts per hour are to be installed, the notice says.

The development of the national economy would be affected if the tasks were not completed, the notice warned.

Observers say this indicates that China will have to accelerate development of the power industry or else it will face power shortages in the future.

China's power production capacity, which stands at some 165 million kilowatts per hour, will be extended to at least 280 million by 2000.

That means the country will have to install power generators capable of producing 13 million kilowatts per hour in 1993 and also in 1994.

And in each of the next 5 years, generators capable of producing 15 million kilowatts per hour will have to be installed.

Between 1988 and 1992, power production capacity was increased by 60 million kilowatts per hour. Some 50 billion yuan ($8.77 billion) was used to build power plants in each of the years.

China, with a population of more than 1 billion, will have to take strong measures to accelerate power production, officials from the industry warned.

The growth of the gross national product is expected to be 8 or 9 percent and this requires parallel growth of power production.

In China, to gain a capacity of 1 kilowatt per hour needs an investment of 3,400 yuan ($596). That means some $69 billion in investment is needed if generators to produce 115 million kilowatts per hour are to be installed.

If the targets are set at 160 million kilowatts, per hour, $95.4 billion is needed.

For 2 years, Chinese senior officials have repeatedly stressed the necessity to accelerate faster development of the power industry.

Premier Li Peng has said China welcomes investment from overseas to launch power projects.

Several Sino-foreign power generating joint venture agreements have been signed. Some of the ventures are already under construction.

This year, electricity charges are such that they not only meet production costs but also permit power stations to make profits.

As such, experts say more foreign investors will get involved in China's power industry.

Reports show Chinese enterprises are also enthusiastic about joining efforts to invest in the industry.

Railroads, Mines Part of Nation's Most Ambitious Energy Development Project

936B0055D Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 5 Feb 93 p 1

[Article by reporter Wang Zenghai [3769 1073 3189]: "Report of Victory in First-Phase Project To Ship Coal from West to East China, China's Energy Resource Development Project With the Most Investments and Largest Scale, Yearly Clean Coal Output 10 Million Tons, Completion of 300 Kilometers of Railway"]

[Text] After 6 years of surveying, design, and construction, the first-phase project in China's project to ship coal from west to east China, which involves development of the Shenfu Dongsheng Coal Field and construction of a new railroad from Baotou to Shenmu and on through Shanxi and Hebei to Huanghua Harbor has been completed and the second-phase project is now fully underway.

There are more than 20 large and medium-sized coal mines already completed and currently under construction at Shenfu Dongsheng Coal Field and a preliminary production scale of 10 million tons of cleaned coal has now taken shape. Of the more than 1,000 kilometers of transport railroad, the 171- kilometer section from Baotou to Shenmu has been completed and is now transporting passengers and freight, over one-half of the

engineering has now been completed on the 250-kilometer railway line from Shenmu in Shaanxi to Shuozhou in Shanxi and it may be completed and opened to traffic at the end of 1994, survey and design work is now underway for the railway line from Shuozhou to Huanghua, and construction of the highway, electric power, communications, and other projects associated with coal field development and railway construction is now pressing forward. The 303 kilometers of asphalt highway criss-crossing the coal field, the mining region power transmission and transformation systems, the communications lines from the coal field to Beijing, and other projects have now been completed and placed into operation.

The start on building the project to transport coal from west to east China, which will involve a total investment of 23 billion yuan, was approved by the State Council in 1986. The entire project will be carried out in three phases. By the end of this century, Shenfu Dongsheng Coal Field will have formed a yearly production capacity of 60 million tons of cleaned coal, and the entire Shuo-Huang (Shuozhou-Huanghua Harbor) railway line will be completed and opened to traffic and have a yearly transport capacity of 100 million tons. The project to transfer coal from west to east China is China's largest energy resource development project in terms of investments and construction scale.

Shenfu Dongsheng Coal Field, which is located in Yulin Prefecture in northern Shaanxi and on the Ordos Prairie in northern Inner Mongolia, now has proven coal reserves of 230 billion tons and long-term prospective reserves of about 669 billion tons, making it the largest coal field discovered in China so far.

Revamped Power Field Awaits New Investors

40100080a Beijing CHINA DAILY in English 6 May 93 p 1

[Article by staff reporter Chang Weimin]

[Text] In a major move to step up China's energy development, the government has announced new policies to attract foreign investment in the power industry.

In briefing reporters in Beijing yesterday on China's ambitious power development programme for the 1993-97 period, the newly appointed Minister of Power Industry, Shi Dazhen, said foreign investment is expected to play a big role.

The Ministry of Power Industry plans to increase the country's electrical production capacity—now about 165 million kilowatts—by 75 million to 85 million kilowatts in the next 5 years.

The increase is much more than originally planned.

Only 70 percent to 80 percent of the financing can be raised domestically, however. Overseas investors are expected to fill the gap, Shi said.

"We welcome overseas investors to launch joint or solely owned power stations in our country," said Shi, who is to serve a 5-year term.

Reports show foreign businesses' interest in China's power industry has grown and more firms are seeking opportunities to start power projects.

In Shandong Province, which needs at least 1.55 million more kilowatt-hours, a foreign exchange quota of $1.5 billion will be set aside to ensure that overseas investors can withdraw their profits in foreign currency.

Letters of intent on $2 billion worth of power projects in the province have been signed with overseas firms, according to Cha Keming, Vice-Minister of Power Industry.

Shi promised strong support to any foreign-funded power project.

China last year produced 740 billion kilowatt-hours, or 600 per capita, only 40 percent of the international average.

About 120 million people in rural areas have no power at all.

The capcity has been overextended with no generators in reserve. A failure of a single machine could immediately curtail power to work units and urban residents.

To pave the way for cooperation with overseas firms, the industry will strongly push forward reforms in electricity pricing and will experiment with shareholding in enterprises. "We expect to have turned the industry into a mechanism in line with the international conventions when (my) 5 years expire," Shi said.

"We must ensure that foreign investors in the industry take back money in terms of foreign currency," he said.

The ministry will strive to raise the present low prices of electricity so that power plants can not only recover the investment in due time but also make profits.

However, Shi said, moderate government control over electricity pricing will be needed to protect consumers' interest.

For decades, the central government has strictly controlled power prices, which have been too low for power stations, all of them State owned, to recoup investment, let alone making profits.

Shi said the ministry has made plans for the pricing system and will support the Pudong New Area in Shanghai to play a pioneer role in pricing reforms.

Also, Shi said, shareholding is set to be adopted in all power stations within 5 years.

Yunnan Takes Steps To Accelerate Electric Power Construction

936B0064A Kunming YUNNAN RIBAO in Chinese 27 Feb 93 p 1

[Article by Yang Liyi [2799 4539 5030] and Zhu Xiangwei [2612 4382 0251]]

[Text] Occasioned by electric power shortages, the Yunnan Electric Power Bureau's leading Party group pushing ahead with enterprise reform, studied and set down measures for accelerating electric power development in Yunnan, and put electric power construction on a new track. From 1981 to October 1990, a 3.5 billion yuan investment was put into large- and medium-sized electric power construction projects in the Yunnan network. Newly installed generating capacity rose by 1,217.5MW, exceeding the total for the previous 30 years and annual average power output increased by 9.93 percent. By the end of last year, the installed capacity of the network reached 2,607MW and annual output surpassed 10 billion kWh, which has been a great boost for Yunnan industrial and agricultural production and reform. But, Yunnan electric power still lags behind the growth of economic construction, especially during dry periods when industry is in urgent need of electric power. Beginning in February, the Electric Power Bureau adopted the following four measures to speed up economic construction:

—Put new units into operation as soon as possible. Guarantee that the first unit of the Manwan hydropower station is operating before 30 June, and the second unit by year's end. Raise money and manpower to get the Qujing power plant renovation project and the Yangzonghai 200MW unit conversion project operating as soon as possible, and raise the total volume of new capacity up to 2,150MW.

—Speed up the development of the hydropower resources of the Lancang Jiang middle and lower reaches, and meet the Ninth 5-Year Plan goal for exporting power from Yunnan. By the end of the Eighth 5-Year Plan, the Manwan hydropower station's first-stage project, the Qujing power plant, and the Yangzonghai power plant expansion project must be completed, and the Dachao Shan hydropower station should be largely completed to increase the total new installed capacity on the Yunnan network by 3,175MW (not including the middle- and small- sized power stations), and raise the total figure up to about 5,600MW, doubling it in 8 years, and reach the annual output target of 19.8 billion kWh. By 2010, after the Xiaowan hydropower station and the Zhaotong power plant come on line, the total installed capacity of the network will again be doubled to about 12,000MW, completing the first step in the building of the southwest energy export base.

—Enlarge the network; unify within and export out. Guarantee that Yunnan's first 500,000 kV Man-Kun transmission line becomes operational this year, hasten construction of the 220 kV and 110 kV transmission lines on the major network to the six prefectures and zhous of Lincang, Simao, Xishuangbanna, Dehong, Zhaotong and Nujiang, get the six areas connected in the Eighth 5-Year Plan, and from those points, extend on to the counties and villages and cover the whole province by the end of the Eighth 5-Year Plan.

—Use every means possible to raise money for managing electric power. The Yunnan Electric Power Industry Bureau, besides lining up proportionate funding from central authorities, must go after foreign funds, and raise funds within and outside the province as well for a joint power management operations. The stock system is now being tested and electric power certificates are being circulated, and a policy for subsidizing expenses and raising electric power construction funds will assure rapid growth in electric power construction.

Xinjiang Accelerates Electric Power Construction

936B0056A Urumqi XINJIANG RIBAO in Chinese 23 Jan 93 p 1

[Article by reporter Ma Xin [7456 2450]: "Xinjiang Accelerates Pace of Electric Power Construction, 240 Million Yuan in Capital Construction Investments Completed in 1992, 230MW in New Installed Generating Capacity Added, Power Output Reaches 8.6 Billion kWh"]

[Text] Xinjiang Electric Power Bureau has seized the excellent opportunity for achieving a westward slant to the state's energy resource strategy, opening up an Eurasian continental bridge, implementing a boundary development policy in Xinjiang Uygur Autonomous Region, and so on, and has continually accelerated development of its electric power industry. A total of 242.2 million yuan in electric power capital construction investments was completed in 1992, which was 109 percent the annual plan. Xinjiang added 234.8MW in installed generating capacity generating capacity and 279.7 kilometers of new 110 kV high-voltage power transmission lines, and yearly power output reached 8.6 billion kWh. This was the fastest year in electric power construction and development in history.

The primary characteristics of electric power construction in Xinjiang are: 1) Construction preparations and starts for more large generators. After the No 4 generator (one 100MW unit) at Manas Power Plant was placed into operation at the beginning of 1992, construction got underway on three large generators: the second phase expansion project (two 100MW units) at Manas and the No 9 generator (one 100MW unit) at Hongyanchi Power Plant built with capital raised by the state, local area, and individuals. 2) Construction starts on more high-voltage power transmission and transformation projects. The placing into operation of the high-voltage power transmission projects from Manas Power Plant to Karamay Oilfield, from Korla to Lunnan Oilfield, from Jinghe to

Alataw Shankou, and others have injected powerful vitality into petroleum development in Xinjiang Uygur Autonomous Region and invigoration of frontier trade. 3) Ascendancy of hydropower construction. The completion of Kaxgar Second Cascade Hydropower Station (three 88MW units) and in particular Dashankou Hydropower Station (four 30MW units) is an indication that hydropower consumption in Xinjiang has leapt up to a new stage. 4) Attention to preparatory projects and reinforcement of development reserve strengths. They have established the Xinjiang Electric Power Construction Preparatory Work Leadership Group headed by Xinjiang Electric Power Bureau director Su Haiquan [5685 3189 3123] and established project headquarters for nine projects including the Manas Power Plant second phase project, Urumqi fourth power source, and others and now have one group under construction, one group being planned, and one group in reserve.

CWM Technology Enters New Phase

936B0064B Beijing JINGJI RIBAO [ECONOMIC DAILY] in Chinese 3 Mar 93 p 3

[Article by correspondent Lu Xiangdong [4151 0686 2639]]

[Text] Under the aegis of the State S&T Commission, State Planning Committee, Ministry of Energy Resources, and China National Coal Mine Corporation, many Chinese scientists and technicians have been making progress on a new clean fuel derived from coal which can be used in place of oil, toward which an important first step has been taken in the formation of a multi-disciplined operation by setting up a frontier venture in an industrial-use test factory for research and development of coal-water mixture (CWM).

State Councillor and Minister of the State S&T Commission, Song Jian, attended the examination and acceptance ceremony to cut the ribbon for a Sino-Swedish cooperative venture, the Beijing Mining Bureau CWM model factory. The CWM model factory is based on imported Swedish technology with Chinese embellishments for advanced technological compatibility and increased reliability; has accommodating facilities and a logical technological layout approved by experts, and will have a batch processing capability. The construction and operation of this factory marks a practical new step toward the development and industrialization of CWM technology in China.

The development of CWM as a new coal-derived liquid fuel that can replace oil, began in the 1970s. It maintains the physical and chemical performance of raw coal, and also has the desired fluidity and stability of oil. Because it is cheap and easy to process, and raw materials are plentiful, as an oil substitute it saves energy, saves transportation, protects the environment, and has low polluting high efficiency, it has caught the attention of industrial interests around the world, and large sums of money have been invested by the U.S., Italy, Japan, Russia, and Sweden for its research and development.

China's energy structure is based on coal. Coal occupies first place among energy resources, and makes up 76 percent of all energy resources consumed. The development and utilization of CWM technology for use in place of oil has obvious economic and social benefits. CWM has been listed by the State Council as a key development product, and with a goal of having a pipeline capability of 30 million tons and replacing 10 million tons of oil by end of century, it has taken its place in the long-range plans for S&T development in China.

Five Big Electric Power Groups Established

936B0057B Beijing GUANGMING RIBAO in Chinese 13 Jan 93 p 1

[Article by reporters Zhang Chaowen [1728 6389 2429] and Pan Shantang [3382 0810 2768]: "China Announces Establishment of Five Electric Power Groups, Li Peng Encourages Electric Power Employees To Move Up to a New Stage"]

[Text] The establishment of the five large North China, Northeast China, East China, Central China, and Northwest China electric power groups was announced in Beijing on 11 January 1993. Premier Li Peng attended the founding meeting and gave a speech. He encouraged leaders at all levels and all employees on China's electric power battlefront to contribute more to accelerating electric power development and move the economies of all the regions up to a new stage more quickly and in a better way.

Premier Li Peng, who has worked on the electric power battlefront for nearly 30 years, was especially pleased regarding the establishment of the five big electric power groups. He represented the State Council and expressed his enthusiastic commemoration to the five big electric power groups in his capacity as an old worker in the electric power industry.

He said that enterprise groups are a new organizational arrangement that has appeared as an objective requirement for adaptation to China's socialist market economy and socialized large-scale production. The establishment of these five big electric power groups is an important reform in our electric power management system and a product of reform of the economic system. During the past several years, the electric power industry has carried out reforms in accordance with the principle of "separating government and enterprises, making provinces the entity, integrating grids, unified dispatching, and raising capital to develop power" and the principle of "adapting to local conditions and to grids" that have created the conditions and laid a foundation for establishing the five big electric power groups. It is precisely reform that has gradually moved the electric power industry onto the path of forming groups. Practice has proven that an industry like electric power, which concerns important aspects of our national economy and people's livelihood, should take the path of forming groups.

Li Peng pointed out that enterprise groups should have a substantial degree of independence while also being subject to macro regulation and control by the government. The establishment of the groups will play a major role in fulling fostering the guiding role of state-run large and medium-sized enterprises, promoting the rational application of the factors of production, forming the advantages of colonies, and increasing the effectiveness of the state's macro regulation and control.

Evidently, these five newly-established big electric power groups were founded on the basis of five former large power grids in China. Through several years of unified planning, dispatching, and operation, they have formed enterprise groups with excellent overall economic benefits.

Jiangxi Accelerates Power Construction

936B0057C Beijing JINGJI RIBAO [ECONOMIC DAILY] in Chinese 11 Feb 93 p 3

[Article by reporters Zhou Dianxia [0719 3949 1115] and Li Hou [2621 0624]: "Jiangxi Accelerates Electric Power Construction, Electric Power Must Lead the Way if the Economy Is To Move Forward"]

[Text] Jiangxi Province has adopted effective measures to accelerate electric power construction and established the power construction principle of "major efforts to develop thermal power, active development of hydropower, appropriate acceleration of nuclear power". Its electric power construction projects for 1993 include four thermal power plants, three hydropower stations, nine power transmission circuits, and 13 power transformation stations for a total investment of 1.36 billion yuan. This is the most in history in terms of both construction projects and investments.

In 1993, besides placing the expansion project at Pingxiang Power Plant into operation, there will be new construction starts on building the third phase at Jiujiang Power Plant and the expansion projects at the Jingdezhen and Xinyu Power Plants. Development will also be accelerated at the Dongjin and Taihe Hydropower Stations and the Suichuan Jiang cascade. Preparatory work will be done in 1993 for Fengcheng Power Plant, a large thermal power plant with an installed generating capacity of 1,200MW, and construction will begin in March 1994. Preparatory work for nuclear power, wind power, and pumped-storage power stations will also unfold in a comprehensive manner.

To ensure the capital for construction, Jiangxi Province has adopted the method of raising capital through multiple channels, including the use of nearly 300 million yuan in Japanese yen loans and Bank of China Group loan capital, and the state is investing 380 million yuan while local areas have raised 690 million yuan on their own. The amount of foreign capital used for electric power construction in 1993 in Jiangxi will be the greatest ever.

Hubei, Henan, Guizhou Construction Update

936B0057A Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 1 Mar 93 p 1

[Article by Wang Gaixian [3769 2395 3807]: "Hubei, Henan, and Guizhou Reinforce Reserve Strengths in Electric Power Construction, Hubei Starts Construction of Five Electric Power Projects, Henan and Guizhou Invest Over 3.1 Billion Yuan in Electric Power"]

[Text] In 1993, a good momentum in electric power construction has appeared in Hubei, Henan, and Guizhou provinces in the interior of China and reserve strengths are full.

Hubei Province has begun construction of five electric power projects in 1993: Ezhou Power Plant, the second-phase project at Hanchuan Power Plant, the project to "replace small with large [generators]" at Qingshan Power Plant, the Geheyan 500 kV outward transmission project, and so on. The six projects going into operation are the third-phase expansion project at Huangshi Power Plant, the No 1 and No 2 generators at Yangluo Power Plant, the No 1 and No 2 generators at Geheyan Power Station, and so on in an effort to place five large and medium-sized generators with 1,400MW into operation. Hubei Province has set an historical record in projects under construction and capacity placed into operation.

Henan Province has made arrangements to invest more than 1.8 billion yuan in electric power during 1993. It has 15 power generation projects under construction and the Henan Provincial Grid has 1,575MW of capacity under construction. It has reported projects with 8,205MW in capacity and is doing preparatory work for projects with 10,405MW in capacity. This is the largest amount in terms of capital invested, projects initiated, and capacity under construction in the history of electric power construction in Henan Province.

Guizhou Province has experienced an electric power "investment fever" for several years in succession and it has invested a total of more than 1.3 billion yuan in electric power construction capital in 1993, which is 3 times the amount in 1990 and over 40 percent more than in 1992. A project now under construction in Guizhou Province is the Panxian Power Plant where three 200MW units will be installed and the No 1 generator will be connected to the grid and begin generating power in 1993. Construction is also being accelerated on two hydropower projects with a total of 585MW. Guizhou will place 1,545MW in large and medium-sized generators into operation during the last 3 years of the Eighth 5-Year Plan, which is about 4 times the amount during the Seventh 5-Year Plan, and 2 years later Guizhou will reverse its long-term power shortage situation. In addition, Guizhou will begin transmitting seasonal power to Guangdong in June 1993.

Correctly Estimating Role of Hydropower in Energy Resource Development Strategy

936B0053 Beijing SHUILI FADIAN [WATER POWER] in Chinese No 12, 12 Dec 92 pp 6-11

[Article by Yang Zhirong [2799 1807 2837] of the State Planning Commission and Chinese Academy of Sciences Energy Resources Institute: "Correctly Evaluating the Status of Hydropower In Our Energy Resources Development Strategy"]

[Text] Difficulties and slow development rates in hydropower construction have consistently perplexed China's energy resource development activities and there is an urgent need to open a new route in the areas of energy resource development strategies and policies to accelerate hydropower construction.

I. Improve Our Understanding of Hydropower

A. Fully understand the advantages of hydropower

Hydropower resources are a renewable energy resource and the earlier they are developed the sooner they will produce results and the more they are developed the more benefits they will provide. Hydropower does not consume mineral fuels and is the cleanest energy resource. There are no thermal links in hydroelectric power generation, it has an extremely fast response to load fluctuations, and when used in conjunction with thermal power or nuclear power to assume responsibility for peak loads it can reduce the amount of coal consumed to generate electricity. Besides power generation, the development of hydropower can also provide comprehensive benefits in flood control, irrigation, shipping, water supplies, timber floating, breeding, tourism, convalescence, and so on.

B. Correctly understand the coal replacement benefits and capacity benefits of hydropower

The coal replacement benefits of hydropower refer to the amount of coal replaced each year per 1 kW of hydropower when using hydropower as a replacement or substitute for thermal power. The capacity benefits of hydropower are the thermal power capacity replaced by 1 kW of hydropower when using hydropower as a replacement or substitute for thermal power. Because production technologies are different for hydropower and thermal power, the geographic deployments of their power stations and their working characteristics are different. To reflect the coal replacement benefits and capacity benefits of hydropower objectively and realistically, we must have comprehensive and systematic concepts and conform to the following basic principles:

1. A consistent production system scope. The production systems should include the entire process from primary energy resource development to energy resource conversion and on to power transmission and the terminal end. Thermal power must be viewed as an entity for joint management of coal, power, and transportation to maintain the comparability of hydropower and thermal power in terms of system scopes.

2. Equivalent terminal electric power and power output. The effects of plant power use and power transmission must both be taken into consideration for hydropower stations and thermal power plants, and thermal power plants must also consider the effects of coal extraction and transportation so that identical effective supplies of electric power and power output are achieved for terminal power use to maintain the comparability of hydropower and thermal power in effective output terms.

3. Identical working modes. Hydropower and thermal power must assume identical burdens and have identical working positions in electric power systems to maintain the comparability of hydropower and thermal power in terms of operating conditions.

The deployment of hydropower stations is not as flexible as thermal power plants. When they are rather distant from load centers their power transmission losses are usually double those of thermal power. The production process of hydropower is simple and its self-use of electricity is 25 to 30 times less than thermal power plants. Substituting hydropower for thermal power in responsibility for peak loads can increase the coal replacement benefits by 50 percent compared to thermal power in base load operation. Hydropower does not require the electricity that is used to extract coal, which can increase the power capacity by 2 percent and reduce coal used to extract coal. Long distance transportation of coal for use in generating thermal power loses 2 percent of the coal at a minimum. Taking the above factors into consideration and calculating average coal consumption at a projected 0.35 kg [per kWh] of standard coal for thermal power generation from 1990 to 2000 and an average utilization time of 3,800 to 4,000 hours for hydropower equipment, the amount of coal replaced per year by 1 kW of hydropower is 2.5 tons. When hydropower stations are distant from load centers and thermal power plants are regional power plants, 1 kW of hydropower can provide 6 percent in capacity benefits, meaning that 1 kW of hydropower can replace 1.06 kW of thermal power. When the thermal power is a pit-mouth power plant distant from load centers and the hydropower stations are also distant from load centers and both have identical power transmission distances, 1 kW of hydropower can provide 10 percent in capacity benefits, meaning that 1 kW of hydropower can replace 1.10 kW of thermal power.

It should be pointed out that in energy resource planning, investment analysis, and other areas, 3 tons is usually adopted as the coal replacement benefit for hydropower. This figure was calculated based on average yearly power output from 1 kW of thermal power and coal consumption for power generation, and it does not reflect the actual situation for thermal power and exaggerates the coal replacement benefits of hydropower.

However, there is also an amount of coal replaced by hydropower that is calculated using the yearly power output per 1 kW of hydropower and average coal consumption for thermal power generation from energy resource balance tables. This figure was 2.1 tons in 1991, for example, but it does not place hydropower and thermal power on a basis of comparable conditions and thus devalues the coal replacement benefits of hydropower. The coal replacement benefit of hydropower is actually 2.7 tons.

When selecting power sources, hydropower and thermal power must be configured in the same working modes before they have a comparable value, meaning that they assume the responsibility for identical tasks in a power system. If hydropower stations are not used to assume responsibility for system peak loads, it is essential that thermal power plants replace the working position of hydropower stations. Under identical operating modes, the have identical yearly average utilization times and there is no question of the amount of electricity output per kW each year for hydropower being smaller than that for thermal power. There are methodological errors in the statistical data that show a lower average yearly utilization time for hydropower compared to thermal power equipment and affirm that yearly output per kW of hydropower is less, that the investment per 1 kW in power output is higher, and that 1 kW cannot replace 1 kW, and they conceal the advantages of hydropower in the areas of frequency regulation, coal conservation, and increased capacity. People have long turned this advantage of hydropower capacity benefits into a disadvantage. This has had an obstinate impact on China's policymaking organs, and it requires a new understanding and objective assessment.

C. Impartially evaluate the investment benefits of hydropower

The cost of hydropower is lower than thermal power and the construction schedules for hydropower and thermal power are not that different when coal extraction and transportation construction are added. From the system concept, the investment for hydropower, thermal power, or even nuclear power should include the entire process from primary energy resource development to the ultimate supply of electric power, meaning the investment that must be made under conditions of their assuming responsibility for identical tasks when they attain identical social benefits. Thus, besides the investment in thermal power itself, consideration must also be given to the coal replacement benefits and capacity benefits of hydropower, to investments in power transmission for hydropower and thermal power, investments in coal haulage, the share of investments for comprehensive utilization of hydropower stations, the added investment for dust and sulfur removal for coal-fired power, and other comprehensive factors. Based on the current situation, if we assume a per kW investment of 3,500 yuan for hydropower and 2,000 yuan or thermal power, an investment of 800 yuan per kW for power transmission, an investment of 250 yuan each for extracting and transporting a ton of coal, a comprehensive utilization share coefficient of 0.2 for hydropower and an added investment coefficient of 0.3 for coal-fired power dust removal and desulfurization, the total investment per kW of hydropower is 3,600 yuan and the total investment per kW of thermal power is 4,059 to 4,285 yuan (regional thermal power and pit-mouth thermal power). Thus the total investment for thermal power is usually 16 to 22 percent higher than hydropower.

Under the existing investment system, investments for coal extraction, transportation, and thermal power plants are established separately, and operational mechanisms for investment shares in comprehensive utilization hydropower projects have not yet been established. Moreover, while the failure of coal-burning power plants to install dust removal and desulfurization equipment, the social benefits of hydropower, and the social hazards of thermal power actually exist, they are not taken into consideration in decision making, and single item investments in hydropower and thermal power play a decisive role instead of comprehensive investments. This is truly a serious defect in decision-making behavior. Thus, establishing overall and complete economic benefits, reforming the existing investment system, and readjusting the existing financial and taxation systems are essential if we wish to accelerate the development of hydropower construction.

II. Readjust Investment Policies, Provide Hydropower With Self-Development Vitality

With the exception of a small amount of retained profits in the profits of electric power departments (including hydropower and thermal power) at the present time, they are all turned over to the state's financial administration in the form of profits and loan repayments and electric power departments in turn receive various types of loans from the state for use in capital construction, and no mechanisms for the direct conversion of profits from electricity sales into capital construction investments have taken shape. The electric power industry, which is based on maintaining electricity prices at low levels, has seen the profit rate on its capital decline every year, falling from 12 percent in 1980 to 4 percent at present, so it lacks a capacity for loan repayment and a self-development capability. In a situation of powerful pressure from electricity demand, we basically cannot consider accelerating the development of hydropower.

The give hydropower, thermal power, and nuclear power self-development vitality, the most fundamental thing is of course raising electricity prices and reducing taxes. Electricity prices should also undergo controlled fluctuation with changes with the construction costs of power plants, loan interest rates, fuel prices, wage levels, market supply and demand, and so on, and the profits obtained from this should be used for investments in electric power construction. In a situation in which it is difficult to straighten out prices and the tax system quickly, investment policies have become an important factor affecting the development of hydropower.

A. Reduce interest rates on hydropower loans, lengthen the time limit for loan repayment

In weighing differential profit rates for the "shift from allocations to loans" in capital construction, coal and petroleum extraction, energy conservation measures, and agriculture (including chemical fertilizer, etc.) are designated grade 1 and enjoy the preferential treatment of floating downward by 30 percent from the interest rate on loans for fixed assets. Hydropower also involves energy resource production enterprises, using hydropower to replace coal is also an important energy conservation measure, and hydropower frequently also provides benefits in flood control and irrigation, so it totally has the conditions for being included in grade 1. Nevertheless, hydropower has been designated grade 2 and only floats downward by 20 percent, which has reduced the attractiveness and loan repayment capability for the investment of social capital in it. I propose that it be readjusted to grade 1.

The policy of "shifting from allocations to loans" for capital construction includes time limits on loan repayment including the construction schedule. Large and medium-sized projects cannot exceed 12 years and huge projects cannot exceed 15 years. The construction schedule for large and medium-sized hydropower projects generally takes about 8 years and huge hydropower project generally take 15 years, so they basically are incapable of repaying loans on schedule. Under the existing financial and taxation system, if we fail to consider the share of investments for hydropower stations and coal-burning power plants fail to install dust removal and desulfurization equipment, and if hydropower and thermal power both implement the policy of new prices for new electricity sources and identical prices for electricity supplied to grids, hydropower's total equivalent benefits after the repayment of loans and interest for hydropower and thermal power throughout their entire operating periods will be far superior to those of thermal power and it will have long-term economic benefits. However, the construction cost per 1 kW for hydropower must be below 2,000 yuan before the loan principle and interest can be repaid within 15 years. Most hydropower stations are incapable of repaying loans within the scheduled time period stipulated in the shift from "allocations to loans", which will inevitably impede taking full advantage of China's enormous hydraulic energy potential. If construction loans for hydropower could be reloaned one time after the 15 year schedule ends, meaning that the loan repayment schedule would be extended to 30 years, the investment per kW in hydropower could be raised to 3,000 yuan, which would give a substantial portion of our hydropower a loan repayment capability.

Based on China's conditions and borrowing from the experiences of developed countries, extending the loan repayment schedule limits for hydropower to 25 to 30 years and providing a 5 to 8 year broad schedule would be more appropriate. Or, we could adopt a policy of successive borrowing and permit the use of new bonds to pay off old bonds to open a path for the existence and development of hydropower.

B. The state should provide suitable subsidies for comprehensive utilization hydropower projects

Frequently, the investments appropriated to hydropower projects are hard to implement because of conflicts of interest among various water-using departments, and this has made hydropower development more difficult. I propose that the state provide appropriate subsidies to projects with obvious comprehensive utilization objectives, especially those with ambiguous public welfare targets. The state can reduce its investments in flood control, irrigation, shipping, water supply, timber floating, and other substitute projects and use the increased taxes collected from comprehensive utilization benefits to repay this portion of the investment. The best method is to establish a "Central Hydropower Development Fund" and use 10 to 30 percent of the investment in comprehensive utilization hydropower stations along with state investments or uncompensated or low-interest loan arrangements to support hydropower and reduce some of the loan repayment pressures on hydropower projects.

C. Establish a "Central Hydropower Development Fund"

A prerequisite for self-development of hydropower is the availability of its own capital on a substantial scale. The current electricity price policies, financial and taxation systems, and investment system have made it impossible for cheap hydropower to achieve self-accumulation, which is a direct factor behind the inability of hydropower development to extricate itself from its difficulties.

While we have implemented the raising of capital through a variety of channels to develop electric power in recent years, the fact that hydropower's construction schedules are relatively long, that it produces results slowly, and that it is not appropriate for short-term behavior have resulted in the capital raised by local areas and the investment direction of the capital of the Huaneng Company being concentrated on thermal power to meet the pressing urgency of our power shortages. Investments in hydropower as a proportion of total investments in electric power dropped from 33.4 percent in 1980 to 17.7 percent in 1990 and the hydropower capacity placed in operation also dropped from 42 percent to 13 percent, so the development of hydropower is even more difficult than before reform.

To solve the problems of China's serious power shortage and insufficient electric power construction capital, we have now implemented a drive policy for the development of electric power by local areas that collects 0.02 yuan per kWh from the electricity used by all enterprises to serve as a special fund for local electric power capital construction. Based on the current situation, excluding

reductions and exemptions from collection, over 5 billion yuan is actually collected each year and this has played a major role in promoting local areas to develop power.

At a time when operational mechanisms for the direct conversion of hydropower profits into capital construction investments have not yet been established, a relatively practical transitional policy is to borrow from the method of local areas having special funds to develop power and temporarily collect 0.01 to 0.02 yuan per kWh of electricity used. Based on present power use levels and the situation in reductions and exemptions from collection, 3 to 6 billion yuan could be collected each year. Added to the investment subsidies provided by the state to large and medium-sized comprehensive utilization hydropower stations mentioned previously, establishing a "Central Hydropower Development Fund" and using this as the primary factor for investments to develop hydropower in west China in conjunction with adopting non-compensated or low-interest loan arrangements and the corresponding operational mechanisms could give hydropower a self-development vitality and gradually reverse the long-term sluggish situation in hydropower construction.

III. Give Preference to Developing Hydropower, Promote the Raising of Grades and Substitution for Energy Resources

China still has hydraulic energy reserves equivalent to 1 billion tons of coal or 500 million tons of petroleum. Giving preference to the development of hydropower, improving the energy resource structure, and promoting the raising of grades and substitution for energy resources is a strategic policy that should be clarified for energy resource construction.

A. Developing hydraulic resources as soon as possible and giving preference to the development of hydropower is a successful international experience

The geographic environment and social and economic conditions of each of the developed countries are different and they have great variations in reserves of combustible minerals and hydraulic resources and extremely great differences in their distribution, but one consistent aspect has been the development of hydraulic resources as soon as possible during their industrialization stage and preference for the development of hydropower.

Before the 1960's, hydropower as a proportion of the power generation structure was over 50 percent in Japan and France and over 85 percent in Canada, Italy, and Sweden, while Norway relied almost entirely on hydropower, and the United States maintained its 30 percent proportion for over 20 years. After the 1960's the proportion of hydropower gradually declined and is presently 20 percent in France and Italy, 48 percent in Sweden, and 60 percent in Canada, and still holds at over 99 percent in Norway. Hydropower as a proportion of the world's power output dropped from 30 percent in 1960 to the present figure of 19 percent and was 20 percent in China in 1990, which is equivalent to the world average level after a substantial reduction in the proportion of hydropower. Total electricity output from hydropower in the world in 1988 was 2.1 trillion kWh, equal to 22 percent of its developable power output. The latter figure is 34 percent in the United States, 57 percent in Canada, 70 percent in Sweden, 74 percent in Japan, 80 percent in Italy, and 90 percent in Norway, France has developed nearly all of its total, and it is 21 percent in the former Soviet Union. Power output from hydropower in China was 126.4 billion kWh in 1990, equal to 6.6 percent of our developable power output and less than one-third of the world average level.

The amount of hydropower resources available in seven countries, the United States, Canada, Japan, Norway, France, Sweden, and Italy, is just 17.5 percent of the world total, while their power output from hydropower accounts for 44.6 percent of the world total. China is the world's leader in hydraulic energy reserves with 19.8 percent but our power output from hydropower is just 5.2 percent of the world total.

Historical practice in the world's development of hydropower shows that power source construction in all of the developed countries was led by fostering hydropower advantages.

B. Changing our energy resource structure dominated by coal is an important condition for promoting social change

Compared to petroleum, natural gas, hydropower, and nuclear power, coal has a lower heat value and higher ash content, is inconvenient to transport and causes serious pollution, and has a low ultimate utilization efficiency, so it does not meet the requirements of a superior quality high-efficiency modern society. On a world scale, coal moved out of the dominant position in energy resource consumption during the mid-1950's. After more than 40 years of major social changes since the Second World War, the world's total energy resource consumption now exceeds 10 billion tons of standard coal, and coal accounts for only one-third of that. The United States, Federal Republic of Germany, and the former Soviet Union are all lower than the average world level and those that are even lower include Japan at 24 percent, Canada at 14 percent, France at 11 percent, Italy and Sweden at 9 percent, and Norway at just 5 percent. The shift of the energy resource structure from dominance by coal to dominance by oil and gas is an important condition that has spurred modern socioeconomic development. There are just nine countries in the world now where coal dominates consumption. Based on coal as a proportion of energy resource consumption in 1988, they are in order South Africa at 85.4 percent, Korea at 85.3 percent, Poland at 80.5 percent, China at 78.8 percent, the former German Democratic Republic at 74.5 percent, Vietnam at 68.6 percent, India at 68.1 percent, Czechoslovakia at 64.3 percent, and Mongolia at 63.3 percent. It is obvious that most of the countries where

consumption of coal has been the dominant factor in the long term are relatively backward countries in economic terms. In China, coal accounted for 76.2 percent of total energy resource consumption in 1990, which is an unfavorable factor in the area of optimizing our energy resource structure. The developed nations made major efforts to develop hydropower during their industrialization phase when consumption of coal was the dominant factor, and this played a substantial role in improving their energy resource structures. For example, Japan was a country in which consumption of coal was the dominant factor prior to the 1950's but hydropower accounted for more than 30 percent and petroleum surged into the consumption realm in large amounts after the 1960's, and after the 1980's nuclear power also partially replaced the status of hydropower in the energy resource balance. Hydropower continues to hold a decisive status in the energy resource balance now in several countries, for example 45 percent in Norway, 21 percent in Sweden, and 13 percent in Canada. Practice has proven that among the five main forces in the world's energy resources, coal, oil, gas, hydropower, and nuclear power, it was hydropower that served as the vanguard in optimizing energy resource structures and reducing the proportion of coal consumption.

C. Accelerate the development of hydropower resources, develop toward a sustainable energy resource system

Energy resources are an important material foundation for social development and the fountainhead of modern civilization. Human society has also gone through three energy resource eras, firewood, coal, and petroleum, and is now in a new transitional period. This transitional period is characterized by a shift from petroleum as the center to renewable energy resources as the foundation for the establishment of an enduring, renewable, and clean energy resource system to adapt to social development and S&T progress.

In China's situation of a low quality of energy resource supplies, long-term supply shortages, substantial pressures on coal extraction and transportation, and hard-to-control environmental pollution, if we wish to achieve our strategic objectives for social development, we must absorb the intelligence of mankind, conform to historical trends, move quickly to take the initiative in improving our energy resource structure and combine major efforts in petroleum and natural gas exploration and development with fully fostering our hydropower resource advantages and actively developing nuclear power.

The essence of the new transitional period in evolution of the world's energy resource structure is promoting a transition from combustible mineral energy resources to renewable energy resources. For China, in the large-scale development of renewable energy resources, hydropower is far more competitive than nuclear fission, solar energy, wind power, marine energy, and biomass energy both in technological and economic terms, and it is practical and feasible. Countries with relatively abundant hydropower resources that still have not developed them to a high degree have made accelerated development of hydropower consumption a focus of their energy resource development strategies and developed countries are now reassessing hydropower resources that previously were considered unsuitable for development. Changes in the world's energy resource structure provide an opportunity to foster China's hydropower advantages and we should not miss this opportunity again.

D. Thermal power as the main factor, preference for development of hydropower, active development of nuclear power

During the past 40-plus years, China's power source construction principles have been readjusted on many occasions and we have gone through five phases: "thermal power as the main factor", "hydropower as the main factor", "combined development of hydropower and thermal power, adaptation to local conditions, developing more hydropower", and "adaptation to local conditions, combined development of hydropower and thermal power, gradually shifting the focus to hydropower", and "adaptation to local conditions, combined development of hydropower and thermal power, appropriate development of nuclear power". In reality, hydropower has held at about 20 percent of our power output and about 27 percent of our installed generating capacity, and an energy resource structure configurations of "hydropower as the main factor" and "combined development of hydropower and thermal power" have never occurred. From the perspective of the power source structure that has already taken shape and energy resource development trends, thermal power will continue to be the dominant factor for quite some time into the future.

Giving preference to the development of hydropower requires that hydropower construction be placed in the primary position in power source construction and acceleration of the pace of hydropower construction to achieve a sustained increase in the proportion of hydropower. Of course, preferential development of hydropower does not mean that this must inevitably lead to a power source configuration of "combined development of hydropower and thermal power" or "hydropower as the main factor". Hydropower construction has been lagging for a long time, which has already posed difficulties for fostering our hydropower advantages. While adherence to the principle of preferential development of hydropower during the next several decades will be unable to transform the configuration of "thermal power as the main factor", this is certainly the most practical and reliable way to optimize China's energy resource structure, alleviate our electric power shortages, reduce the burden on railway transportation of coal, and clean up our environment, and it conforms to the long-term interests of social development.

Furthermore, we must have a long-term strategic view and actively develop nuclear power. Continually increasing nuclear power as a proportion of our power source structure is one of the main features of raising

grades and substitution in modern society's energy resources. Taking into consideration the ever-growing shortages of energy resources in China's more economically developed regions and the limitations of railroad coal haulage, we should have more active consideration and arrangements for nuclear power construction.

IV. Our Installed Hydropower Generating Capacity Will Reach 80,000MW in the Year 2000

A. Compensate for energy resource shortages, improve our energy resource and power source structures

Projected demand for primary energy resources in China in the year 2000 is expected to be 1.5 to 1.6 billion tons of standard coal and the estimated amount of possible supplies is about 1.4 billion tons. At that time our energy resource exports will still be maintained at the present level and our supply/demand shortage will exceed 200 million tons of standard coal.

To accelerate the pace of economic development, we will have to attain the power generation goals of an estimated 280,000MW in installed generating capacity and yearly power output of 1.4 trillion kWh in the year 2000, and the installed hydropower generating capacity should reach 80,000MW of this amount. If we achieve this objective, hydropower as a proportion of power output will rise from 20 percent in 1990 to 23 percent in 2000 and the hydropower as a proportion of capacity will rise from 26 percent to 29 percent. The extent of utilization of power output from hydropower resources will rise from 6 percent to 17 percent and the degree of capacity utilization will rise from 9.5 percent to 21 percent. Hydropower as a proportion of primary energy resource production will rise from 4.7 percent to 7.5 percent and actually replace 200 million tons of coal. Estimating coal supplies in China in the year 2000 at 1.5 billion tons, coal used to increase power output from 1990 to 200 will account for 60 percent of new increases in coal output, which is slightly higher than the 1990 level.

B. Reduce the coal transportation capacity shortage, promote a regional fuel and motive power balance

China has a shortage of railroad coal transportation capacity and coal shipments account for 43 percent of the volume of freight that is hauled. This will become even more acute in the future. The amount of coal transported out of Shanxi, Inner Mongolia, and Shaanxi in 2000 will account for 92.5 percent of the total amount of coal that is hauled across provincial borders in China and the amount of coal that will be hauled to other areas will reach an estimated 486 million tons, more than 3 times the amount that was actually transported out in 1990. The amount expected to be shipped into the northeast China region will be 2.8 times that in 1990, and it will be 2.6 times as much to east China and 6 times as much to southeast China. Coal transport will become one of the primary factors that will restrict a regional fuel and motive power balance. The existing railroad capacity for transporting coal out of Shanxi, Inner Mongolia, and Shannxi is 270 million tons and there is still a 216 million ton shortage in transportation capacity. We must accelerate technical upgrading of existing railroads and open up new transportation lines. The channels for shipments into coal-short regions also have problems in meeting needs. After technical upgrading of the routes for transport into the east China and southeast China regions, there will still be an estimated 60 million ton shortage in shipping capacity. If Sichuan wishes to haul part of its coal in from Shaanxi and Shanxi, it will have an estimated transportation capacity shortage of more than 7 million tons. If we are unable to make rapid improvements in railroad, maritime, and other transportation capacity conditions, this will be a great threat to the achievement of a fuel and motive power balance by the year 2000. Taking into consideration a regional fuel and motive power balance and coal transportation capacity conditions, accelerating the pace of hydropower construction in the east China and southeast China regions has urgent practical significance.

C. Accelerate development of hydropower in northwest and southwest China

To achieve the goal of attaining an installed hydropower generating capacity of 80,000MW in the year 2000, we must accelerate development and construction of large and medium-sized hydropower stations on the middle and upper reaches of the Huang He, Chang Jiang, and Zhu [Pearl] River, which have superior conditions.

1. Start by satisfying growing regional demand for electricity use and adopt the required drive policies in the economic area to motivate the initiative of local areas for building hydropower to facilitate population resettlement, shorten construction schedules, and improve the returns to investments.

2. Consider the fact that regions with concentrated hydraulic resources are precisely those regions with abundant non-ferrous metal ore reserves. Hydropower construction should be integrated with development of the electrometallurgical and electrochemical industries to make use of local hydropower and spur regional economic development. In addition, coordinate with the development of the west China hydropower base area, implement the principle of a westward shift in the strategic deployment of big electricity users, and make full use of west China's hydraulic resources to reduce the pressures from growing electricity use in the east China region. Furthermore, along with developing hydropower in west China we should adopt measures to deregulate electricity use by residents and public institutions, reduce the roundabout transport of fuel and motive power, and improve regional social welfare levels. Starting now in considering the synchronized construction of power sources and users is an important condition for accelerating hydropower construction in west China.

3. Because our hydraulic resources are concentrated in remote mountainous areas of west China and their development is relatively difficult, it would be best to use

river basin or regional plans as a foundation to formulate comprehensive development programs, concentrate forces to implement cascaded and successive development, and avoid large-scale and long-distance transfers of construction staffs and equipment to reduce hydropower station construction costs and shorten construction schedules.

4. Exploit potential in existing hydropower stations, give primary consideration to the possibility of expansion to increase capacity, and build more pumped-storage power stations in regions with shortages of hydraulic resources and peak regulation capacity. In addition, we must start soon in doing research on a concrete program for "transmitting power from west to east China" to enable good preparations to be made for large-scale development of hydropower in west China after the year 2000. Prior to 2000, move as quickly as possible to develop hydropower on the middle and upper reaches of the Huang He and transmit power to the North China Grid to satisfy its peak regulation requirements. Accelerate the development of hydropower on the middle and upper reaches of the Chang Jiang, work first to satisfy increased demand for electric power in the Sichuan region, and focus hydropower development on the middle and upper reaches of the Zhu Jiang on large and medium-sized hydropower on the Hongshui He to serve as a power source base area for the south China region and try to achieve the "transmission of power from west to east China" as quickly as possible.

In summary, we should stand on the heights of the long-term interests of the state, understand the status and role of hydropower in our energy resource development strategy in the three areas of "resources, the environment, and energy conservation," and actively create the policy conditions for its healthy development. The development of hydropower is a difficult point in China's energy resource construction. There has been a great deal of discussion and too little implementation. We cannot miss the opportunity again. We must do careful research and make resolute decisions.

Shuikou Begins To Impound Water

93P60219 Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 15 Apr 93 p 2

[Text] Recently, the Shuikou hydropower station—the largest hydropower station in terms of installed capacity in the East China Power Grid—lowered its sluice gates and began to impound water. With an investment of 5.3 billion yuan, the Shuikou hydropower station is the first such project in the history of the nation to make use of a World Bank loan. The station's total installed capacity will be 1400MW and it will have a yearly output of some 4.95 billion kilowatt-hours of electricity, about one-third of Fujian Province's power generation capacity at the present time.

Tibet Rich in Hydropower, Geothermal Resources

936B0051D Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 30 Jan 93 p 2

[Article by reporter Hu Xisheng [5170 6007 3932]: "Tibet Is Making Major Achievements in Combined Hydropower and Geothermal Development, Tibet Autonomous Region Has Built 441 Power Stations and 60 Percent of Its Counties Are Being Supplied with Electricity"]

[Text] Tibet Autonomous Region has made gratifying achievements in combined development of hydropower and geothermal energy in its energy resource development and construction. Tibet has completed 441 power stations to date with a total installed generating capacity of more than 160MW. They include 435 hydropower stations with an installed generating capacity of 115MW and two geothermal power stations with an installed generating capacity of 27MW, and there are also four thermal power plants. Total electricity output in Tibet Autonomous Region reached 370 million kWh in 1992 and 60 percent of its counties are being supplied with electricity.

Tibet Autonomous Region has relatively abundant hydraulic resources with theoretical reserves of about 200,000MW that include 56,600MW in developable hydropower resources, which are, respectively, first and third place in China. Over 600 geothermal indication regions have been discovered now with an estimated power generation potential of 800MW, the champion in all of China.

Tibet's electric power industry came into existence starting with the construction of its first hydropower station in 1950, Duodi Power Station, and it has strengthened and continued to develop. Eight hydropower stations including Nyingchi Bayi, Qamdo, Shannan. Lhasa Xianduo, and others were completed and several 10 additional small county, township, and village hydropower stations were also built. Since reform and opening up, a new high tide of electric power construction has arisen in Tibet. The autonomous region expanded or built 10 power stations in 1991 with a total installed generating capacity of 102.55MW and three of them have now gone into operation and are generating electricity. The golden era of geothermal development has also arrived. Now the Yangbajan [Yangbajing] geothermal field, Ngari Prefecture's Langjiu geothermal field, and Nagqu Prefecture's Nagqu geothermal field have been developed or are under construction. The largest in scale is Yangbajan geothermal field, which is at an elevation of 4,300 meters above sea level and has an installed generating capacity of 25.18MW, first place in China and 16th place in the world. Tibet Autonomous Region has now formed in a preliminary fashion the Lhasa, Nyingchi, Qamdo, Shannan, and Xigaze power grids.

Tianshengqiao Second Cascade Station No 1 Generating Unit On Line

936B0051B Nanning GUANGXI RIBAO in Chinese 23 Dec 92 p 1

[Article by reporter He Ming [0149 2494]: "No 1 Generator at Tianshengqiao Second Cascade Hydropower Station Goes On Line, Another Bright Pearl Added on the Hongshui He, Another Achievement in China's Economic Construction, Congratulatory Telegrams Arrive from the State Council, Li Peng, Zou Jiahua, and Qian Zhengying Send Their Congratulations, Wang Guangying, Li Zhenqian, Officials from the Guizhou Provincial Government and People's Armed Police Central Team, and Others Cut Ribbon for Trial Generator Operation To Generate Power"]

[Text] The No 1 generator with an installed generating capacity of 220MW at Tianshengqiao Second Cascade Hydropower Station, a key state project, was successfully tested and generated power at 1030 hours on the morning of 22 December 1992 as the powerful current was connected to the South China Grid and began steady transmission to outside areas. With this, another bright pearl was added to the Hongshui He.

The State Council sent a telegram enthusiastically commemorating this major achievement in electric power construction in China and economic construction in Guangxi Zhuang Autonomous Region and expressing cordial solicitude to the builders of the power station. Premier Li Peng wrote a few words to commemorate the connection to the grid and power generation by the No 1 generator: "indomitable struggle, enormous contributions". State Council Vice Premier Zou Jiahua [6760 1367 5478] and National People's Political Consultative Conference Vice Chairwoman Qian Zhengying [6929 2973 5391] also wrote words of commemoration.

On the morning of 22 December 1992, a majestic ribbon-cutting ceremony was held at Tianshengqiao Power Station. National People's Political Consultative Conference vice chairman Wang Guangying [3769 0342 5391], Guangxi Zhuang Autonomous Region CPC Committee Standing Committee and Guangxi Zhuang Autonomous Region vice chairman Li Zhenqian [2621 2182 3383], and officials from the Guizhou Provincial Government and the People's Armed Police Central Team attended the meeting and cut the ribbon for trial operation and power generation by the No 1 generator.

The ribbon cutting ceremony was conducted in the tall and clean power plant building. At 1030 hours, as the leading comrades did the cutting, operating personnel pressed their buttons and the huge water turbines underneath the plant building screeched and began turning, at which time the builders in the plant building enthusiastically applauded to hail this moving moment.

Tianshengqiao Second Cascade Hydropower Station, built with an investment of 1.58 billion yuan, was a key state construction project during the Seventh 5-Year Plan. The power station has a total design installed generating capacity of 1,320MW and will generate an average of 8.8 billion kWh of electricity a year, making it one of the few large hydropower stations that can be counted on one's fingers at the present time. The overall plan for the power station is to install six large water turbines, each with a unit capacity of 220MW. The successful testing of the No 1 generator this time and its going into operation to generate electricity will contribute to alleviating power supply pressures in Guangxi Zhuang Autonomous Region and spurring economic development in Guangxi, Guizhou, and Guangdong.

Tianshengqiao Second Cascade Hydropower Station is located on the Nanpan Jiang in the upper reaches of the Hongshui He, and it involved a great deal of engineering and complex strata. The large dam and plant buildings were built on unusually tall slopes and the water diversion tunnels pass through an underground limestone, dolomite, and sandy shale zone with gushing water, faults, exploding rock dust, and pouring water that made construction extremely difficult. Despite this, the officers and men of the People's Armed Police First Hydropower Central Team responsible for building the project coordinated closely with all of the construction units in an 8-year struggle that eventually conquered a variety of hardships and dangers to build a 470 meter long and 60.7 meter tall dam on the shoals, drill three water diversion tunnels 8.7 to 10.8 meters in diameter running a total length of 30 kilometers through the middle of a large mountain at a depth of 300 to 800 meters, and enabled the No 1 generator to produce electricity without problems.

Dashankou Station Completed, On Line

936B0051C Urumqi XINJIANG RIBAO in Chinese 31 Dec 92 p 1

[Article by reporter Wang Xuelin [3769 1331 2651]: "Dashankou Hydropower Station Completed and Producing Electricity, Premier Li Peng Writes Warm Words of Encouragement"]

[Text] After 72 hours of trial operation at full load, the last water turbine generator at Dashankou Hydropower Station, the largest hydropower project in Xinjiang Uygur Autonomous Region, was formally connected to the grid at 2116 hours on 21 December 1992 and began generating electricity. State Council Premier Li Peng offered these words: "enthusiastically commemorate the completion and power generation of Xinjiang's Dashankou Hydropower Station."

Dashankou Hydropower Station is located in Hejing County on the southern flank of the Tian Shan and is a key water conservancy and hydropower project on the Kaidu He that will have power generation, flood control, and other comprehensive benefits. The power station has a total installed generating capacity of 80MW and will generate up to 300 million kWh of electricity a year. The total investment was more than 200 million yuan.

Microcomputer monitoring and control systems are used for its control functions and they have attained advanced levels in China of the late 1980's.

This key project in Xinjiang Uygur Autonomous Region was surveyed and designed by the Xinjiang Water Conservancy and Hydropower Survey and Design Academy. The People's Armed Police Communication Headquarters, Third Construction Corps, Agricultural Division Second Construction Corps, and other units were responsible for construction of the three big key projects, which were the large river impoundment dam, the water diversion tunnels to generate electricity, and the main and auxiliary plant buildings and voltage raising stations. The Xinjiang Hydropower Construction Company was responsible for installation of the machinery and electrical equipment.

During the construction process, the construction, design, and building units coordinated closely and pooled the wisdom and efforts of everyone to develop and successfully apply large numbers of new technologies and new techniques, and they accumulated valuable experience in building water conservancy and hydropower projects on Xinjiang's complex geological structures.

Tianhu Station Phase-1 Construction Completed

936B0051A Shijiazhuang HEBEI RIBAO in Chinese 2 Dec 92 p 4

[Article by reporter Lu Yongjian [7773 3057 1696]: "Hydropower Station with Largest Head in Asia Completed in Guilin"]

[Text] Guilin, which has long enjoyed a reputation of being first under the heavens, has new pride. The first phase project at Tianhu Hydropower Station, which has the largest head in Asia, was recently formally completed in Guilin Prefecture and began generating power.

Minister Yang Zhenhuai [2799 2182 2037] of the Ministry of Water Resources, who came from Beijing for the ribbon cutting, announced to the more than 1,000 guests that this was the only hydropower station in Asia at present with a head greater than 1,000 meters and that each cubic meter of water here could generate 2.37 kWh of electricity, whereas it takes about 20 cubic meters of water at regular hydropower stations to generate 1 kWh of electricity. A new member of China's more than 60,000 hydropower stations, Tianhu Hydropower Station is located in Quanzhou County in Guilin Prefecture and has a head of 1,074 meters. The project was formally initiated in 1987. After it is completed in its entirety, it will link together 13 high mountain reservoirs at an elevation of more than 1,450 meters above sealevel into a single unit. It will mainly generate electricity during the fall and winter dry seasons and will have a total installed generating capacity of as much as 6,000MW. The experts have indicated that the pressure-bearing capacity of the specially fabricated manganese steel piping that this hydropower station will use to divert water can be favorably compared to a nuclear submarine and that the water turbine generators used at the power plant have the highest technical levels in China.

Dachao Shan Update

936B0064C Kunming YUNNAN RIBAO in Chinese 2 Mar 93 p 1

[Article by Miao Xiaoyang [4924 2556 7122] and Zhu Xiangwei [2612 4382 0251]]

[Text] Electric power construction in Yunnan has taken another step forward: The preliminary design report for the Dachao Shan hydropower station was formally submitted for examination on 26 February, and construction may begin by year's end.

The Dachao Shan hydropower station, located on the Lancang Jiang at the boundary of Yun County in Lincang Prefecture and the Jingdong Izu Autonomous County in Simao Prefecture, is the next cascade station downstream from the Manwan hydropower station in the Lancang Jiang middle and lower reaches cascade development program, its dam site being 70 kilometers on a straight bearing from the Manwan station. The Dachao station, a multi-purpose project intended mainly for generating electric power, will have a 91.2 kilometer long reservoir with a capacity of 890 million cubic meters, six generators totalling 1,350MW of installed capacity, and an average annual output of 5.931 billion kWh. This station will be a great help in relieving the imbalance of supply and demand for electric power in Yunnan at the close of this century and into the next, for the development of the Lancang Jiang economic zone, and for exporting energy from Yunnan to end the energy shortage situation in the southwest.

Design work for the Dachao station began in 1980. The Kunming Survey and Design Academy formally selected the dam site in March 1980 after repeated surveys. The design mission was undertaken by the Ministry of Energy Resources, Ministry of Water Resources, Beijing Survey and Design Academy, and the Kunming Survey and Design Academy, and from 1983 to early 1993 a lot of laboratory and outside research and investigation was done to make proper preparations for formal start-up of construction.

According to the Electric Power Bureau authorities, Dachao station will be built with central and local funds, and the total budget will be over 6.4 billion yuan, of which 60 percent will be raised by the National Energy Investment Corporation, and 40 percent within Yunnan Province. Last year, the participating departments invested over 40 million yuan, and the roads to the construction site and electric power facilities were completed. Construction of the transportation facilities needed inside the site is now being stepped up. After the design report passes the examination committee, which is made up of famous experts from around the country, the large-scale operations will get underway to put the first unit into formal operation by 1999.

5,000MW Taishan Plant Will Be Largest in Asia

936B0055B Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 6 Feb 93 p 1

[Article by special reporter Wang Genghui [3769 2577 6540]: "Asia's Largest Thermal Power Plant To Be Built in Taishan County, Guangdong"]

[Text] The State Planning Commission formally approved establishment of the Taishan Power Plant project on 14 January 1993 and construction recently got underway at Tonggu Bay in Tiantou Town, Taishan City, Guangdong.

This large power plant, which will install a total of eight generators with a power generation capacity of 5,040MW, is apparently the largest thermal power plant in Asia at the present time.

The power plant will be built in two phases. The investment in the first phase will be about 13 billion yuan (calculated at current prices) and utilizes a Sino-foreign joint investment arrangement. An effort will be made to place the first 600MW generator into operation by the end of 1996.

To meet the needs of power plant construction, the relevant departments will also build a matching 50,000 ton pier, large coal yard, and cement highway connecting the residential and plant areas.

Agreement Signed With Spain on Importation of Two 350MW Units for Henan Plant

936B0061 Zhengzhou HENAN RIBAO in Chinese 14 Feb 93 p 1

[Excerpts] Premier Li Peng and Prime Minister Gonzales of Spain were present this morning at the contract signing ceremony between China and the Spanish INI Consortium for the construction of two 350,000-kilowatt coal-burning generators to be installed in the Yahekou thermal power plant. [passage omitted]

Yahekou is a key project in the nation's Eighth 5-Year Plan. It is also the third largest power plant in the province, after the Yaomeng power plant and the Shouyangshan power plant. The two imported generators are supplied by the Spanish INI Consortium, with a contract price of over U.S.$300 million. According to the contract, the two generators will be put into operation by the end of 1995 and in 1996 respectively. The completion of the Yahekou thermal power plant will play a significant role in bringing out to the fullest extent the advantages of the province's coal reserves, in relieving the power crunch of Henan Province and in promoting the economic development of the province. [passage omitted]

The generators of Yahekou thermal power plant were imported through the use of Spanish export credit. This is also the first time that the Spanish Government has exported a 350,000-kilowatt generator to China. It is one of the largest items in the trade between the two countries in recent years.

Prospects for Natural Gas Exploration in China

936B0031 Jiangling SHIYOU YU TIANRANQI DIZHI [OIL AND GAS GEOLOGY] in Chinese Vol 13, No 3, Sep 92 pp 237-244

[Article by Wang Tingbin [3769 1656 2430] and Feng Fukai [7458 4395 7065] of the Ministry of Geology and Mineral Resources Petroleum Geology Institute, Beijing, 100083: "Geological Characteristics and Exploration Prospects of Natural Gas in China"*; manuscript received 25 January 1992]

[Text] Abstract: Our overall train of thought is to start with an analysis of basins, make heat the main line, and use the concept of dynamic equilibrium to study the geological characteristics of China's natural gas. Using basins, heat, and hydrocarbons as the theoretical foundation and focusing on the formational environment and resource distribution of natural gas, our article proposes three interrelated comprehensive classifications of basins (heat classification, structural classification, and oil and gas proportion classification). China's natural gas comes mainly from four domains (immature strata systems, coal-bearing strata systems, carbonate rock systems, and lacustrine clastic rock systems) that are divided into five genetic categories (biogenic gas, biogenic-heat catalyzed transition zone gas, oil-type gas, coal-formed gas, and deep source gas). The geological conditions for the formation of large and medium-sized gas pools are: the comprehensive result of substantial gas generation intensity, conventional reservoir strata of substantial thickness, relatively late gas generation periods and accumulation periods, development of paleouplifts and paleotraps, excellent regional capping strata, faults and unconformities as conductors, and so on. There are four main types of gas-bearing domains (coal-formed gas, marine facies carbonate rock gas, lacustrine sapropelic gas, and biogenic gas) and the ranking of resource prospects for the four large gas-bearing provinces are: the offshore gas province, northwest China gas province, central China gas province, and east China oil and gas province. The overall principle for future natural gas exploration in China is moving forward with large, medium-sized, and small regions and giving combined consideration to the long, medium, and near terms.

Key terms: China's natural gas; geological characteristics; dynamic equilibrium of basin heat and hydrocarbon generation, transportation, accumulation, and diffusion; combining large, medium-sized, and small areas; combined attention to the long, medium, and near terms

Brief introduction to main author: Wang Tingbin, male, age 56, professor-level advanced engineer, petroleum geology

Energy resources are one of the keys to implementation of China's magnificent grand plan for socialist modernization, and the development of China's natural gas industry to alleviate China's energy resource shortages cannot be delayed. For this reason, the state's key project to attack S&T problems during the Seventh 5-Year Plan, "Research on Geological Theory and Exploration Technology for Oil and Gas Fields", made deployments for a "Research Project on Natural Gas (Including Coal-Formed Gas) Resource Evaluation and Exploration and Testing Technology (Number 75-54-01)". The Ministry of Geology and Mineral Resources, China Petroleum and Natural Gas Corporation, Chinese Academy of Sciences, and State Education Commission jointly organized huge S&T forces to launch an integrated attack on key S&T problems.

Abundant achievements were made in attacking key problems during the 5-year period. The rate of growth in natural gas reserves during the Seventh 5-Year Plan was double that during the Sixth 5-Year Plan, making it the period of the fastest growth in natural gas reserves in China and fully embodying the enormous motive power of S&T as the first force of production. Because of space limitations, this article will focus on introducing the main ideas in the project and its understanding of the geological characteristics of China's natural gas.

I. Research Ideas

There are two basic factors in the generation of oil and gas: materials and the effects of heat. The former is the foundation and the latter is the condition. Different geodesic backgrounds and different basin categories and basin development and evolution phases determine the type of the sedimentary material, the richness and type of the organic matter, the characteristics of the reservoir rock, and the category of the traps. Different geothermal field characteristics and "heat" effects determine the formational and evolutionary history and the lithification and pore evolution history of oil and gas as well as the migration and accumulation characteristics of natural gas in different basins.

Generation and accumulation of natural gas in basins is the comprehensive result of dynamic equilibrium among various comprehensive factors. We stress that the function of "heat" is the closest bond that links sedimentary basins with the presence of natural gas. During the course of natural gas generation and accumulation, the role of heat is the most vital factor.

Compared to petroleum, natural gas has multiple sources and the generation of gas involves multiple stages, its migration has multiple phase states, and there are multiple forms for its output categories. It is also strongly diffusive and more difficult to preserve than petroleum.

As a result, the generation and reservoiring processes for natural gas include its mineralization time and preservation time, which are the comprehensive result of its dynamic equilibrium in its accumulation and diffusion under specific geological conditions.

Thus, focusing on the most central issue in natural gas geology and evaluation, i.e., starting with analysis of basins, making the role of heat the main line, and using

the concept of dynamic equilibrium to study the geological characteristics of natural gas in China, is the overall idea for attacking key S&T problems related to natural gas during the Seventh 5-Year Plan.

II. Comprehensive Categorization of Three Types of Basins

A. Hot structural regions and basin heat categories

China as a whole can be divided into four hot structural regions: 1) High heat structural regions: two new structural activity zones during the Tertiary to late recent periods, meaning the Himalayan hot structural zone and the hot structural zone in the deep central marine basin of the South China Sea and nearby Okinawa sea trench; 2) Hot structural zones: the coastal Pacific structural region, meaning the extension structural zones and magmatic activity zones after the late Mesozoic where many hot point anomalies are found; 3) Low heat structural regions; and 4) Moderate heat structural regions: the central-west China compression structural zone, old structural zones prior to the late Mesozoic, and hot event inactive zones after the late Mesozoic.

China's basins can be divided into four categories on the basis of two fundamental factors: the primary parameters of convection value (Q) and ground temperature gradient (G):

1) High heat basin category; 2) Hot basin category: Songliao, Erlian, Bohai Bay, Nanxiang, Subei [northern Jiangsu]-Southern Yellow Sea, East China Sea, and South China Sea basins; 3) Moderate heat basin category: Ordos, Sichuan, Qaidam, Hexi corridor, and Chuxiong; 4) Cold basin category: Tarim and Junggar Basins.

B. Structural categories in basins

Overall, China's basins can be divided into two main categories. Category 1 is cold and moderately hot compression basins that are mainly located in western and central China. Their formation and development are closely related to the evolution of the Tethys structural system, especially the intense subsidence that was restricted by the uplifting of the Qinghai Plateau in later periods. These are called Tethys basins. Category 2 is hot extension basins located in the eastern continental region and in marine areas that are related to interaction between the Pacific Plate and Eurasian Plate. This can be called the coastal Pacific basin category, and its greatest characteristic is especially intense hot structural activity since the late Mesozoic.

The compressive basin categories are: cratonic basins, foreland basins, basins in mountain-building zones, and cratonic subsidence-folded basins, the foreland basins among them being the most important and the most important gas-bearing zones. The extension basin categories are: inland rift valleys, inland rift subsidences, small ocean basins, passive margin basins, and back-arc basins. Inland rift valleys are mainly oil basins while passive margin basins and back-arc basins are mainly gas basins.

C. Classification according to oil and gas resource proportions

Gas basin category: gas is the main factor and gas resources account for over 70 percent of the total amount of oil and gas resources in these basins. the Sichuan, Ordos, East China Sea, Chuxiong, Southwest Taiwan, Yangzi region (southern carbonate rock region), Southeast Qiong, and Yinggehai are eight example basins. They contain 49 percent of our natural gas reserves.

Oil basin category: oil is the main factor and oil accounts for over 70 percent of the total resources in these basins. The natural gas resources in the 11 oil basins where we have computed the amount of resources, including Bohai Bay, Songliao, Subei, Nanxiang, Jianghan, Qaidam, Zhujiangkou, and others, have 20 percent of China's total resources.

Oil-gas basin category: Gas and oil each account for roughly equal proportions. Examples include Tarim, Junggar, Turpan-Hami, and He-Huai basins. Their gas resources account for 30 percent of China's total resources.

These three categories are reflections of the close interrelatedness and causality of basins, thermal fields, and oil and gas resources.

Analysis based on the concept of dynamic equilibrium indicates that in basins from somewhat older eras, cold basins are more favorable to the formation and preservation of natural gas because they are characterized by slow evolution and a somewhat later period of peak gas (oil) generation, such as Tarim and Sichuan Basins. Basins from somewhat newer eras as hot basins with better conditions are favorable to the generation and accumulation of gas, such as the East China Sea and Southeast Qiong Basins.

III. Natural Gas and Gas Source Rock

Natural gas is rather widely distributed throughout China and gas fields have been discovered in all of the larger sedimentary basins. With the exception of the Silurian and Devonian systems, it is distributed all the way from the basement metamorphic rock to the Quaternary system. At present, reserves are greatest in the Tertiary system, followed by the Triassic system. They mainly came from four domains: immature strata systems, coal-bearing strata systems, carbonate rock systems, and lacustrine clastic rock systems. The proportions of natural gas reserves in each of these domains are that carbonate rock systems occupy first place, followed by coal-bearing strata systems.

The natural gas can be divided according to the thermal evolution characteristics of the organic matter into the

five main categories of biogenic gas, biogenic-thermal catalysis transition zone gas, oil-type gas, coal-formed gas, and deep source gas.

Biogenic gas: during the early period of lithification in an environment of organic matter reduction, the gas generation potential of the gas produced from degradation by bacteria has been proven by actual results.

Biogenic-thermal catalysis transition zone gas (abbreviated as transition zone gas): this is equivalent to the natural gas that was produced when biogenic gas generation had basically concluded but before catalysis had reached the liquid window stage. It is characterized by immaturity or low maturity of the thermal evolution of the organic matter, with a corresponding temperature of 45 to 95°, $\delta^{13}C_1$ of -5.5 percent to -4.8 percent, and C_1/C_{1-5} = 0.7 to 0.99. There was a relatively large scope of variation in sedimentation environments and water media conditions, with $\delta^{13}D_{CH4}$ of -26.0 percent to -18.0 percent. The natural gas that formed during this stage is very broadly distributed in several Mesozoic and Cenozoic basins in eastern China and has very good prospects.

Oil-type gas: this mainly refers to natural gas generated by thermal catalysis and pyrolysis from types I-II dry casein base, and its source rock includes lacustrine hydrocarbon source rock and carbonate rock source rock. It can be divided further into normal petroleum-associated gas, normal condensed oil and gas, and pyrolytic gas.

Coal-formed gas: organic matter, mainly type-III dry casein base, generated natural gas during the thermal evolution process. As a result of the development of coal system strata in China, several large gas-bearing basins mainly have coal-formed gas (such as the East China Sea and South China Sea Basins).

According to statistics on 38 known petroliferous basins, in all basins (or depressions) where industrial oil and gas flows have been obtained, the maximum hydrocarbon generation intensity is generally greater than 1 x 10^6 t/km^2, so 0.5 x 10^6 t/km^2 has been set as the lower limit for basins where industrial oil and gas flows may be obtained.

The results of thermocompression simulations of various types of source rock under different temperature stages indicate that gaseous stage output rate for all types of source rock in all evolutionary stages increases as the degree of maturity is higher, but there are substantial differences between the various categories of source rock in each evolutionary stage. Overall, the lacustrine mudstone and marine facies carbonate rock that are mainly categories I and II parent matter maintained high gas output rates from beginning to end. China's marine facies carbonate rock has a relatively low liquid state hydrocarbon output rate but a relatively high gaseous state hydrocarbon output rate for the corresponding stages. The limey mudstone and humic coal that is mainly category III parent material generally has a rather low gas output rate. Assessments of the hydrocarbon generation potential of coal strata must be based on the percentage components of each microcomponent before they can realistically reflect the hydrocarbon potential of each type of coal strata.

IV. Reservoiring Conditions of Natural Gas

In China's proven natural gas reserves, clastic rock accounts for 44.1 percent and carbonate rock accounts for 54.8 percent.

China's continental source clastic rock reservoir strata can be divided overall into five combinations. The main one is continental facies sediment fluvial-delta systems that have strongly non-homogeneous material properties, relatively complex lithologies, substantial variations in reservoiring performance, widespread multiple secondary pore development zones, a rather large proportion of non-conventional reservoir strata, and other characteristics.

Secondary pore development zones are the primary reservoiring site for natural gas in clastic rock. Every basin has several secondary pore development zones and the secondary pore development zones have a broad range of depths, but the most important development is the intermediate lithification I-II_A stage (R° 0.7% - 1.0% +/-) and II_B stage (R° 1.3% - 1.5% +/-).

There is a very good relationship of correspondence between the speed of lithification and evolution and the secondary pore development mode in basins controlled by heat fields. Moving from high ground temperature field hot basins (Erlian, Songliao) to low ground temperature field cold basins (Junggar, Tarim), the speed of lithification and evolution slows, the thickness of secondary pore development zones increases, and there are extremely obvious regularities in their depth and breadth.

For this reason, among the multitude of factors that influence lithification and secondary pore development, a basin's category and its development history and thermal history are the primary factors in macro control of change trends. With their control, every basin may have sequential development and regional lithification porous zones (porous zones and compacted zones) moving from shallow to deep areas, and they are not controlled by strata positions and lithology. The porous development zones are distributed mainly between R° 0.6% - 1.5% and have a very good relationship of correspondence to the thermal evolution of organic matter.

Sandy mudstone reservoir bodies composed of fissure networks and secondary pore development zones are the main reservoiring sites for the natural gas in non-conventional reservoir strata and they are not controlled by lithology. Porosity and matrix permeability are not reliable indicators for evaluating the effectiveness of reservoir bodies.

Carbonate rock reservoir strata in China are mainly Paleozoic marine facies and are primarily distributed on the three large residual cratonic blocks. Most are non-conventional reservoir strata series, but they have a relatively high output potential. Most of the good carbonate rock reservoir strata are related to superficial lithification of various types of erosion hiatus surfaces and mainly have integrated pores, holes, and fissures and extremely strong non-homogeneity. They can be divided into three large reservoir systems: porous reservoir systems controlled by the sedimentation environment, fissure-vugular pore (hole) reservoir systems controlled by unconformable surfaces and sedimentary hiatus surfaces, and fissure reservoir systems controlled by tectonism. There are five types of formational factor categories and five types of lithification pore evolution models: Tertiary biogenic reef and beach porous reservoir strata (model A); Paleozoic biogenic reef solution pore dolomite reservoir strata (model B); vugular pore clastic limestone and dolomite reservoir strata (model C); ancient weathered and eroded dolomite and limestone reservoir strata (model D); and fissure-type limestone and dolomite reservoir strata (model E). The model A reservoiring conditions are the best while models C and D are the most widely distributed and have the greatest prospects.

V. Natural Gas Closure, Capping, and Preservation Conditions and Characteristics of Reservoiring and Capping Combinations

Applying the concept of dynamic equilibrium is essential for a rational assessment of natural gas capping strata and preservation conditions. The reason is that the existence of effective capping strata is one of the main causes for the accumulation and pooling of natural gas. While we can use the pressure differential of reservoir and capping strata to make a semi-quantitative projection of the maximum gas elevation and closure and capping capabilities of gas strata, whether or not natural gas has accumulated and formed pools in the traps ultimately depends on the gas sources having a far greater filling capability than escaping capability.

The closure and capping capability of capping strata are determined by pore structure parameters, but are also related to thickness, area of distribution, sedimentation environment, depth of burial, strata era, lithology, and intensity of structural stresses, so they must be combined with actual geological conditions for comprehensive discrimination.

The quality of capping strata directly controls the accumulation coefficients of reservoir strata. However, regional capping strata have the greatest significance in natural gas accumulation and they control the overall vertical distribution of natural gas in basins.

Using a basin's category and evolutionary history as the main line, the reservoiring and capping conditions of China's main sedimentary basins can be divided into three categories, the continuous type (type A), the congruent type (type B), and the compound type (type C). These three types of reservoiring and capping systems developed in different types of basins and each of them have their own unique reservoiring and capping conditions. Overall, type A is the best, type B has the greatest variation, and type C has the poorest closure and reservoiring conditions.

The better reservoir strata segments of carbonate rock are related to various types of superficial activity during different periods, among them two types of superficial activity being the most important. One is a reservoiring and capping combination related to subsequent superficial activity on regional unconformities. The second is a reservoiring and capping combination with multi-cycle characteristics that is related to superficial activity during earlier periods.

Lithification and evolutionary history comprise the evolutionary history of pores and the continual elimination of original pores and the formation and evolution of secondary pores. Basins with simple development histories commonly have continuous-type lithification and pore evolution series. The congruent type is the dominant factor in basins with congruent multiple strata and multiple cycles. The compound type is more dominant in several cratonic subsidence-folded regions which have non-conventional reservoir strata systems.

VI. Key Factors in Natural Gas Pooling

The accumulation and pooling process for natural gas is an evolutionary history of migration, accumulation, and dissipation after natural gas is generated as well as the result of the attainment of dynamic equilibrium under special geological conditions.

Basic experimental research using dynamic equilibrium factors from a variety of areas indicates that natural gas has different migration modes from those of petroleum. They involve a variety of modes including diffusion in water, aqueous solution and liquid discharge, gaseous phase migration, gas-liquid mixed phase, aqueous solution convection, and so on, and the primary migration phase states and migration modes are different for different stages of maturity of different categories of organic matter.

In doing research on the migration, accumulation, and pooling processes of natural gas, we combined with actual basins to establish several two-dimensional dual-phase mathematical models that produced a significant improvement in our understanding of natural gas pooling processes and the precision of quantitative assessments and forecasts of natural gas resources.

China's non-conventional gas pools have abundant natural gas resources. Because compacted sandstone is very widely distributed in China and we have quite a few compacted sandstone gas pools and abundant coal-seam methane resources, categorization of gas pools must first of all divide them into the two main gas pool series of

non-conventional gas pools and conventional gas pools. The goal is to stress that non-conventional gas pool series are a domain that cannot be neglected for China's natural gas.

China currently has 179 gas (oil) fields with proven reserves that are distributed through 15 basins. The fact that gas sources and reservoiring conditions are more widely distributed than petroleum is an indication that finding gas fields is not more difficult than finding oil fields among all of China's basins (or depressions) and it is possible that only gas my be found in certain basins (or regions). However, there are few gas fields and oil and gas fields at present with reserves greater than 100 10^8 m^3 and their reserves account for more than 50 percent of China's total oil and gas reserves, which is an indication that finding large and medium-sized gas fields has major significance for rapidly increasing China's natural gas reserves.

The main factors in the formation of large and medium-sized gas fields with rich accumulations in China are: 1) The presence of gas source rock in substantial strength is the material foundation for the formation of large and medium-sized gas fields. 2) Large and medium-sized gas fields mainly accumulate in clastic rock conventional reservoir strata of relatively great thickness and in dissolution pore (hole) type carbonate rock reservoir strata. 3) Gas generation in late periods and pooling in late periods are the most favorable for the formation of large and medium-sized gas fields. 4) Early period traps in paleouplift regions are favorable to the formation of large and medium-sized gas fields. 5) The role of regional capping strata cannot be ignored. 6) Faults and unconformities play an important role in the accumulation of natural gas. 7) The intensity of secondary gas generation is an important factor in whether or not Paleozoic gas sources were able to accumulate into large and medium-sized gas fields. 8) A multi-reservoir type and nearby reservoir type are the main migration and accumulation forms for China's large and medium-sized gas fields. 9) A combination of geological factors that do not play their roles independently comprise together the macrogeological background that is controlled by a basin's category and evolution, and they are the comprehensive results of a dynamic equilibrium that is a series of interrelationships among basins, thermal histories, and hydrocarbon generation and pooling.

Upper Triassic system compacted sandstone gas pools in the Western Sichuan depression are an example of non-conventional gas accumulations in China. Because the time the rock was compacted was earlier than the formation of structural traps and the peak of gas generation was also slightly later than the rock compaction, fissures are the primary migration channel for natural gas. Pooling and migration certainly do not involve all of the pore spaces in the strata. They only involve part of the pores that are interrelated to fissure systems and the gas often relied on the fissures to accumulate and form pools. Anomalous pressure systems controlled the formational environment for gas pools.

The western Sichuan compacted strata gas pools (fields) and North American deep basin gas are both located in foreland basins that have a formational association with Mesozoic mountain-building zones, but the degree of compaction in the west Sichuan region is greater than in North America. No gas accumulations have been found yet in synclines in western Sichuan, nor have any abnormal conditions related to gas and water been discovered. Moreover, high-pressure and super-high pressure anomalies are common, so it is another new category of compacted gas pools different from the water-enclosed gas pools in North America.

VII. Evaluation and Projection of China's Natural Gas Prospects

China has four primary large gas-bearing domains: coal-formed gas, marine facies carbonate rock gas, lacustrine sapropelic gas, and biogenic gas. Among them, the first two are the two most important gas-bearing domains and the main exploration targets in the future. Biogenic gas is not widely distributed but it is an important domain in several basins. A substantial portion of the lacustrine sapropelic gas is gas associated with oil fields and it can be given consideration at the same time we are prospecting for petroleum.

A. Coal-formed gas domain

Coal-formed gas accounts for a relatively high proportion of China's total natural gas, and coal-formed gas occupies the primary status in our large and medium-sized gas fields (pools). The discovery of these gas fields and the positions in which they are located provide sufficient illustration that China's coal systems have substantial gas exploration prospects.

Two types of coal-formed gas have been discovered so far. One is basically gas, such as the Ordos and Sichuan Basins. The second contains mostly gas condensate and light oil, such the Xihu depression in the East China Sea Basin. They are related to source rock category, organic matter composition, sedimentation environment, and basin category.

China's coal-bearing rock systems can be divided into three categories based on the type of basin: rift valley type (fracture-subsidence type), foreland type, and cratonic type. There are significant differences in structural backgrounds, geothermal fields, sedimentation environments, lithology, thickness, and organic microcomponents among these three categories of coal systems that affect their different gas generation potential, pooling regularities, and prospects assessments.

1. Rift valley (fracture-subsidence) type coal systems have relatively superior gas generation conditions. Among them, deep bog coal systems and lacustrine sub-coal systems are better than shallow bog coal systems and could possibly have generated gas as well as oil. An example is the Shahejie group in the Bohai Bay Basin.

2. Foreland type coal systems are mostly continental shallow bogs with few hydrogen-rich components, they mostly generated gas with relatively high lens material and inert material components, and their gas generation strength is far less than the one above. The scale of gas pools is relatively small. An example is the Upper Triassic system Xujiahe group in western Sichuan.

3. Cratonic coal systems, which are characterized by thin coal systems with alternating marine and continental facies sediments. Overall, they are better in northern China than in southern China, but because the coal systems are not thick they do not have sufficiently abundant gas sources, most of the reservoir strata are low porosity and permeability strata systems with relatively poor preservation conditions, and their pooling conditions are the poorest of the three categories. An example is the Carboniferous-Permian coal system of northern China.

B. Marine facies carbonate rock gas-bearing domain

All of China's Paleozoic marine facies strata systems from the middle and upper Protozeroic to the middle and lower Triassic system in southern China are a set of gas-bearing combinations that are primarily marine facies carbonate rock. The gas sources could have come from the carbonate rock itself as well as from marine facies muddy shale strata. This is an important gas-bearing domain and it is the leader in China in total natural gas reserves, presently accounting for about one-half of our proven reserves and output. Because it underwent a relatively long and complex geological history, this type of gas has more complex preservation and distribution conditions than in Mesozoic and Cenozoic basins.

China's marine facies carbonate rock is mainly shallow water platform facies. Because shallow water platform facies are characterized by low organic carbon and being poor in hydrogen and rich in oxygen and have similarities to category III dry casein base, they have a higher gas generation potential and oil generation potential and generated mainly gas, but their gas generation potential is not that high. Thus, the primary gas source rock in the marine facies carbonate rock gas-bearing domain should be basin facies and deeper water platform facies sediments such as the lower Permian system in Sichuan Basin and the Manjiaer Paleozoic depression in Tarim Basin.

C. Lacustrine sapropelic gas-bearing domain

China has very broadly distributed oil generating source rock, most of it in the mature stage, and it produced mainly oil. Only a portion of our basins have relatively abundant associated gas pools that formed natural gas accumulations on a substantial scale.

Although associated gas in oil fields accounts for a very limited proportion, it is widespread in large amounts in several of east China's large oil fields and there could be more substantial growth following the development and discovery of new oil fields.

Very little highly over-mature sapropelic gas has been discovered and there is substantial gas generation potential in deep depressions and continental facies source rock in many of China's basins, so we should pay attention to searching for "secondary" gas fields generated in deep strata and reservoired in shallow strata.

D. Immature biogenic gas domain

This is a gas-bearing domain with a relatively low degree of research and exploration but it does have substantial potential. According to biogenic gas simulation experiments, the gas generation rate is 120 m^3/t for category I organic matter, 90 m^3/t for category II organic manner, and 45 to 55 m^3/t for category III organic matter. China has very widely distributed biogenic gas resources and more than 10 biogenic gas fields have now been discovered located in the Qaidam, Songliao, Erlian, Bohai Bay, and several offshore basins.

Comparative analysis of the prospects of conventional gas and non-conventional gas indicates that the main objective in future exploration for gas in the clastic rock domain should be concentrated on searching for conventional gas fields (pools), that in general the gas-bearing strata are best if not too deep and are better above 4,000 meters, and that newer periods are better than older ones.

The main problem with non-conventional gas is poor reservoir strata, which has meant complexity in natural gas accumulation, distribution, pooling, pressure, output potential, and other conditions and greater difficulty in exploration, but they contain nearly one-half of China's natural gas resources and cannot be neglected.

Overall, the ranking of the natural gas resource prospects of the four main gas regions are: the offshore gas region, northwest China gas region, central China gas region, and Bohai Bay-Songliao oil and gas region. The basins with the most hopeful prospects for finding large gas fields are Tarim, East China Sea, and Ying-Qiong [Yinggehai-Southeast Qiong] basins followed by Sichuan and Ordos Basins. Songliao and Bohai Bay Basins mainly have oil as well as abundant medium-sized and small natural gas deposits, but they are widely distributed and buried at shallow depths, and are suitable for utilization in economically developed regions.

VIII. An Understanding of the Preservation Regularities of China's Natural Gas Resources

1. While there is much natural gas that was paragenetic with petroleum, it does have its own characteristics, and thus we must treat natural gas as a unique mineral.

2. Basins and geothermal fields are the two deciding factors among the factors behind the formation of natural gas and neither is dispensable. Basin-heat-hydrocarbons are the key factors that mostly precisely embody the formational history of natural gas.

3. We must dialectically analyze the effects of hot basins and cold basins on the formation of natural gas.

4. A basin's structure and depositional environment are the main factors that determine the richness of gas sources.

5. Strata sections where clastic rock secondary pores and vugular pores (holes) in carbonate rock developed are the primary targets in the search for large and medium-sized gas fields.

6. Generally speaking, later peak gas generation and pooling periods are better than earlier ones and the search for large gas fields should be in basins or regions that have Cenozoic gas generation and Cenozoic pooling conditions.

7. The main accumulations of natural gas are in gas basins and oil-gas basins and the search for large gas fields should be focused on these two categories of basins. Although the natural gas in oil-gas basins is mainly in medium-sized and small pools, they are buried at shallow depths and widely distributed.

8. Near-source pooling is the main factor in compression-type basins and far- source pooling is more common in extension-type basins.

9. Based on the theory of dynamic equilibrium pooling in natural gas generation, migration, accumulation, and dispersion, research on the formational regularities of large and medium-sized gas fields and exploration for large and medium-sized gas fields are the primary route for rapid development of the natural gas industry.

10. Based on the guiding ideology of basins, heat, and hydrocarbons and on the theory of dynamic equilibrium in natural gas pooling, China's primary basins and regions for large and medium-sized gas fields are: the Ya 13-1 uplift and Ya 21-1 uplift in the Ying-Qiong Basin, the Xihu depression in the East China Sea Basin, the Tabei [northern Tarim] uplift and Tazhong [central Tarim] uplift in Tarim Basin, the east Sichuan region and Weiyuan-Moxi region of the Sichuan Basin, and the ancient buried platform region in the central part of Ordos Basin.

IX. Overall Principles for Future Natural Gas Exploration in China

There are different requirements for basins of different categories and unequal amounts of resources, and exploration and development of China's natural gas resources should be carried out in an orderly manner based on the geological conditions and the degree of exploration and economic geography conditions in each basin.

Near term: select 14 key exploration region blocks including Tabei, Xihu depression, and so on during the Eighth 5-Year Plan.

Medium term: select 12 key regional blocks including Tazhong and others for the focus during the Ninth 5-Year Plan.

Long term: After the year 2000, we should establish 12 new natural gas industry base areas on the basis of work during the Eighth 5-Year Plan and Ninth 5-Year Plan to increase natural gas output to 600 x 10^8 m^3 to 1,500 x 10^8 m^3, which is 4 to 10 times the present level. This will substantially increase natural gas as a proportion of China's energy resource mix.

* This article summarizes 75-54-01 achievements jointly completed by the Ministry of Geology and Mineral Resources' Petroleum Geology Institute, the China Petroleum and Natural Gas Corporation's Exploration and Development Research Academy, the Chinese Academy of Sciences' Lanzhou Geology Institute, and other units. Other persons involved in compiling the final report are: Zhang Shiya [1728 1102 0068], Zhang Hongnian [1728 3163 1628], Liu Guobi [0491 0948 3880], Dai Jinxing [2071 6855 2502], Wei Houfa [1218 0624 4099], Cheng Keming [4453 0344 2494], Kong Zhiping [1313 1807 1627], Xu Yongchang [1776 3057 2490], Kuy Dehan [0491 1795 3352], Lu Jialan [4151 1367 3620], Zhang Yigang [1728 5030 4854], and Li Deli [2621 1795 0448].

Cray Research Markets Y-MP Vector Supercomputer Series in China

93P60230C Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 14, 14 Apr 93 p 3

[Article by Shen Haiying [3088 3189 5391]: "Cray Holds Forum in Beijing on Petroleum Exploration and Supercomputer Technology"]

[Summary] U.S. supercomputer giant Cray Research recently held a "Petroleum Exploration and Supercomputer Technology" forum in Beijing to introduce to Chinese petroleum industry users the firm's traditional mainstream systems, the Cray Y-MP series of vector supercomputers. This series, including a total of six models (Y-MP/EL, Y-MP/2E, Y-MP/4E, Y-MP/8E, Y-MP/8I and Y-MP/C90), is Cray's traditional mainstream model group representing today's highest-performance vector supercomputers. Since the late Eighties, when the series was first marketed, over 100 units have been installed worldwide, capturing 85 percent of the entire supercomputer market. At the forum, Cray especially unveiled its improved EL model intended for the Chinese market: the Y-MP/ELC. It is understood that the Y-MP/EL and Y-MP/2E are to receive export permits for delivery to users in China. Besides petroleum exploration, the Y-MP supercomputers have many applications in areas such as space, the automotive industry,

and government. Cray's Y-MP and S-MP series supercomputers will have a major influence on the development of China's petroleum exploration technology.

New Oil, Gas Pipelines for Country

40100077A Beijing CHINA DAILY in English 16 Apr 93 p 1

[Text] China is planning to build several additional cross-country pipelines from inland oil and gas fields to its industrial centres.

One of the projects, a 1,000-kilometre-long pipeline, will bring natural gas from the newly-discovered Ningxia-Shaanxi gas-field to Beijing.

When operational, the pipeline should help to greatly reduce atmospheric pollution caused by extensive use of coal for heating and cooking in the capital, according to official sources.

The pipeline is expected to be completed before the year 2000, when China hopes to host the Olympic Games in Beijing, a decision that will be forthcoming in late September of this year.

Such pipelines, the most efficient and cost effective method of transporting crude oil and natural gas, have long been used in China and have greatly aided the growth of the energy industry.

At present, 263 major pipelines, totalling about 16,740 kilometres, carry nearly 70 percent of the crude oil being shipped from oilfields to refineries. And nearly all natural gas output is supplied to consumers through these means.

The pipelines, forming a network in the Northeast, North, East and Central China, Sichuan Province and Xinjiang Uygur Autonomous Region, send crude oil to refineries, fertilizer plants, ports and transfer stations.

China's crude oil output was more than 138 million tons last year and that for natural gas was about 15 billion cubic metres.

Analysts foresee a steady expansion of the national pipeline network in the future because the planned high growth of the national economy will likely produce increased demands for more energy.

A report in PEOPLE'S DAILY said that the China Oil and Gas Pipelines Administration has handed over 10.56 billion yuan (about $1.9 billion) in taxes and profits into the State coffer since it was founded in the early 1970s.

The amount is nearly three times the total State investment in the construction of pipelines during the same period.

The administration, with a staff of more than 50,000, is capable of laying more than 1,000 kilometres of pipelines each year.

Many more new pipelines are now under planning and feasibility study. However, the official refused to give further details on these projects.

The administration has also helped to lay more than 1,000 kilometres of pipeline in some foreign countries, such as Iran and Iraq.

Shanghai Jiaotong, Shengli Develop World's Largest Shallow Water Rig

936B0056B Beijing ZHONGGUO KEXUE BAO [CHINESE SCIENCE NEWS] in Chinese 5 Feb 93 p 1

[Article by reporters Huang Xin [7806 6580] and Han Jianmin [7281 1696 3046]: "Shanghai Jiaotong and Shengli Oil Field Successfully Develop the World's First Shallow Water "Dual Perch" Drilling Platform"]

[Text] Shanghai Jiaotong University and the Shengli Oil Field Drilling Technology Research Academy have successfully jointly developed the world's first extremely shallow water "dual perch" drilling platform, the "Shengli No 2".

This platform is 72.24 meters long, 43.14 meters wide, and 59.80 meters tall. It weighs 4,615 tons itself and 10,689 tons when fully loaded, and has a 20 day self-support capability. It has unique internal and external structures and relies on a complete set of huge precision drive systems that can cause the internal and external portions to rise in alternation and work in unison to move it forward or backward and move the entire platform.

Apparently, China's "Shengli No 2" is the world's only walking base drilling platform that can enter extremely shallow sea regions to explore for petroleum that other land-based or marine exploration equipment is incapable of entering. It has a working water depth of 0 to 6.8 meters and can walk like a person does with two legs in extremely shallow sea regions at water depths of less than 2 meters and move forward or backward in the water by taking 10 meter steps so that the drilling activities can be continued on land and sea. This piece of equipment was successfully completed and placed in the water in September 1988. During nearly 4 years of actual use, it has drilled nine wells with a total drilling footage of 23,000 meters and has proven 20 million tons in geological petroleum reserves, which is equivalent to finding 3.5 billion yuan in resource wealth for the state.

New Oil Field Found at Junggar

936B0056C Beijing GUANGMING RIBAO in Chinese 26 Jan 93 p 1

[Article by reporter Zheng Jinming [6774 2516 7686]: "More Good News for Petroleum Development in Xinjiang: Another New Oil Field Has Been Discovered in Junggar Basin"]

[Text] At the end of 1992, several reports of victory were passed on from Xinjiang's petroleum industry: following the discovery of a large integral oil field with reserves in excess of 100 million tons in Tarim Basin, pleasing news is also coming out of Junggar Oil Field now with the discovery of a new oil field in the southern part of the Five Regions 25 kilometers from Karamay.

Petroleum shot out of an 8-meter thick oil stratum in oil strata more than 60 meters thick discovered in the Permian System at the Ke [Karamay] 004 well. The 5 mm oil nozzle produced a daily output of 96 cubic meters in high-output oil and gas flow during trial production. The presence of oil in this well is an indication that a second Cainan oil field exists in Junggar Oil Field.

In addition, 80 meter thick oil strata were discovered in the Jurassic and Permian Systems during exploratory drilling at the Shixi 1 well in the southern structural zone of the central uplift in Junggar Basin. Logging of the oil that gushed from an 20 meter thick oil stratum produced a daily output of 65 tons of superior quality crude oil and more than 10,000 cubic meters of natural gas during trial production from a 4 mm oil nozzle, confirming that the 4,000 square kilometers of the Longnan structural zone is a new zone of oil and gas accumulations.

Progress is also being made in exploration and development of the Turpan-Hami Oil Field and output there may reach 1 million tons of oil in 1993.

There are gratifying prospects for petroleum exploration and development in Xinjiang's three large basins. At the end of 1992, the total amount of proven and controlled petroleum was 2 billion tons and a good start was also made in 1993, which is an indication that breakthrough advances have been made in China's strategic slant toward western China in petroleum development, and it has laid an excellent resource foundation for invigoration of Xinjiang's economy.

Daya Bay Due To Go On Line Soon

40100076A Beijing CHINA DAILY (Supplement) in English 15 Apr 93 p 6

[Text] The Daya Bay Nuclear Power Station, which is 30 kilometres northeast of the Shenzhen Special Economic Zone, will be operational soon.

In the last 3 years, the HCCM Nuclear Power Construction Joint Venture Company, a Sino-French-Japanese consortium led by Campenon Bernard SGE in France, has taken charge of the civil engineering of the Daya Bay Nuclear Power Station, the first high-powered nuclear power station in China.

The Daya Bay Nuclear Power Station's two 900 MW pressurized water reactor stations will start operation early in the fall.

The transmission and distribution system for the Daya Bay Nuclear Power Station includes a power station switchgear, the Shenzhen Substation, the Zengcheng Substation, the Shajiao No. 1 Substation, a pump-storage substation and the 400/500 KV transmission lines.

According to the agreements reached in contracts between China and France, two transformers of 900 MVA will link the two power transmission networks with different voltages so that electricity generated by the Daya Bay Nuclear Power Station can be delivered both to Guangdong Province and Hong Kong.

The latter half of 1992 witnessed the finishing of the equipment installation in the Daya Bay Nuclear Power Station.

The cold functional tests of the Nuclear Island and the combined test of the Conventional Island have been completed. The nuclear fuel assemblies have been delivered safely to the designated site. The installation of the 500 KV transmission line and the performance test of the circulating water pumps also have been completed. According to experts, all the work done has met quality standards.

The Daya Bay Nuclear Power Station owes much of its success to the joint efforts of organizations from several countries, including the Framatome, a French designer and manufacturer of nuclear reactors, which helped design the Daya Bay Nuclear Power Station and supplied equipment to it, and the General Electric of Britain, which provided the conventional power plant equipment to the Daya Bay Nuclear Power Station.

All along the construction period that represents 14 million man-hours, specialized training has been provided to 4,000 local technicians. The supervision was assured by 85 expatriates assisted by Chinese nationals and some 100 technicians from Hong Kong and Singapore. The expatriate team comprised specialists in nuclear power stations and staff with sound experience in the management of major overseas projects. The Guangdhong Nuclear Power Joint Venture Company has attached great importance to establishing a competent operation department and has further strengthened its management team accordingly. A strong command system and weekly operation inspection system have been set up. Notable achievement has been made in the efforts to improve management, complete training programmes, speed up the drafting of operating procedures and arrange support services. Emergency preparation has been enhanced and co-operation between Chinese and foreign experts strengthened.

The construction of the Daya Bay Nuclear Power Station shows that sincere co-operation between different countries is conducive to a large, high-tech project.

On Further Development of Geothermal Resources

936B0035 Beijing ZHONGGUO NENGYUAN [ENERGY OF CHINA] in Chinese No 9, 25 Nov 92 pp 16, 22

[Text of speech by Shen Longhai [3088 7893 3189] of the State Planning Commission Resource Conservation and Comprehensive Utilization Department at the "International Symposium on High-Temperature Geothermal Development and Utilization in Tibet" on 9 August 1992: "Do Better Geothermal Resource Development and Utilization Work"]

[Text] As a new type of energy resource, geothermal energy has attracted the interest of all countries of the world in regard to its special roles in energy resource supplies, economic development, environmental protection, and other areas. This was particularly true during the 1970's with the appearance of two world petroleum crises and increasingly serious ecological and environmental problems which spurred faster growth in geothermal resource development and utilization, and the installed geothermal power generation capacity grew at an annual rate of 10 percent. At present, the world's installed geothermal generating capacity has reached 5,888MW and the scale of direct utilization of geothermal energy for non-power purposes has attained 11,385MW in thermal power. This is especially true for several developing nations where it has grown at a very rapid rate in the past several years. The installed geothermal generating capacity in the Philippines, for example, has grown from the original few 10MW to 894MW, second place in the world. India's installed geothermal generating capacity has grown from 32MW to 143MW, seventh place in the world. Geothermal power generation now accounts for a substantial proportion of total energy resources in other developed countries like the United States, Japan, New Zealand, Iceland, Italy, and others.

China has abundant geothermal resources. They can be divided into two basic categories according to formational factors and heat content. One is the high- temperature water category that is related to magma from recent periods. It has temperatures greater than 150°C and is found mainly in southern Tibet, the Tengchong region of Yunnan, Taiwan, and other regions. Especially noteworthy is the northern part of the Yangbajan [Yangbajing] geothermal field and the Yangyixiang geothermal field where temperatures as high as 204°C have been detected in recent years, and they have a substantial flow rate of high total heat liquids. The second category is the groundwater circulation hot water category that is subject to the effects of ground temperature heating. Its temperatures are generally under 80°C and it is distributed mainly at Shantou in Guangdong, Zhangzhou in Fujian, northeast China, and several other regions. There are now 43 geothermal fields in operation and over 3,000 geothermal points have now been discovered. The proven geothermal resource area is now 10,143.5 square kilometers.

The Chinese government historically has been concerned with geothermal resource surveys, exploration, development, and utilization. This is particularly true for the past 10-plus years, when the Chinese government organized the relevant experts, scientific research units, and plants and enterprises to conduct systematic research to attack key S&T problems in the geothermal field in areas like basic theory, resource evaluation, geological exploration, heat storage engineering, databases, environmental protection, drying, heating, and other types of development and utilization technology, and they have made several achievements that have moved the development and utilization of China's geothermal energy from the natural development stage to the scientific and self-conscious program exploration, rational development, and economic scale development stage. To date, geothermal power generation in China has been focused on Tibet's Yangbajan geothermal field, which has an installed generating capacity of 25MW and provides about 25 percent of the electric power in the Lhasa region, thereby making a positive contribution to alleviating the electricity shortage in the Lhasa region and developing Tibet's economy. We also have 616 mu in total geothermal greenhouse area and over 2,520 mu in total geothermal breeding surface water area, as well as 1.892 million square meters in geothermal heating area and 632 geothermal baths. More than 1,000 geothermal sites are now being utilized in China, equal to one-third of the total number of geothermal sites, and they provide heat energy equivalent to 3.05 million tons of standard coal per year. The utilization of this geothermal energy has revealed significant social and economic benefits in several fields and trained a geothermal S&T and production staff.

Since reform and opening up, geothermal work has made substantial progress in the areas of international exchange and cooperation. Examples include assistance from the United Nations for the development of geothermal resources in Beijing and the first and second-phase geothermal power generation projects in Tibet, the assistance of the Italian government in geothermal development in Tianjin, scholarly exchanges between China and Japan, the United States, France, New Zealand, Iceland, and other countries, and so on. Such exchanges and cooperation have played an active role in promoting the improvement of geothermal theory, technical research, and project construction levels in China.

Because of restrictions by finances, technology, and other factors, many of the regions in China with abundant geothermal resources have not been fully explored and proven geothermal resources are still not being properly utilized. Although they are being developed and utilized, the economic results are poor because of low utilization technology levels, poor management, and so on. Thus, future geothermal work in China should be strengthened in the following areas:

1. Unify planning, conduct geothermal resource surveys properly. Work to develop and utilize geothermal resources should use geothermal resource exploration

and resource evaluation as a basis for formulating a series of development programs and administrative regulations based on resource distributions, characteristics, and categories and their technical and economic properties that are adapted to local conditions for comprehensive utilization and full fostering of our resource potential to obtain the optimum overall benefits.

2. Strengthen scientific research, improve technical levels in geothermal utilization technology. We should conduct multidisciplinary comprehensive research in the areas of geothermal resource exploration and evaluation, thermal energy storage engineering, project design, utilization technology and equipment, resource protection, recirculation technology, environmental protection, and so on, do good demonstration trials and technology extension and application work, and convert scientific research achievements into forces of production quickly.

3. Strengthen domestic and foreign cooperation, spur the geothermal industry in China. In China, further strengthen coordination between all departments, fully foster the role of experts and scholars in the geothermal field and the China Energy Resource Research Commission's Geothermal Specialists' Committee and other civilian groups, while at the same time broadly undertaking international exchanges and cooperation. This is very important for promoting geothermal development and utilization work in China.

Nation's Largest Windpower Station Completed in Xinjiang

936B0055A Urumqi XINJIANG RIBAO in Chinese 1 Jan 93 p 1

[Article by reporter Chen Pengfei [7115 7720 7378]: "Xinjiang Completes China's Largest Windpower Power Plant"]

[Text] The first-phase project at Xinjiang's Central Windpower Generating Plant, the largest in China with an installed generating capacity of 2.4MW, was formally connected to the grid and generated electricity on 27 December 1992. This is an indication that Xinjiang has entered a new stage in the utilization of wind energy. Located in Dabancheng, this wind-powered power plant in conjunction with the wind-powered generating equipment completed by the Xinjiang Wind Power Company in the same region several years ago has increased Xinjiang's total wind-powered installed generating capacity to 4.45MW.

Wind energy is a huge natural resource that nature has provided to Xinjiang. Statistics show that Xinjiang has over 800 million MW in useable wind energy power generation reserves, with over 25 million MW in the Dabancheng region alone. Using wind energy to generate electricity has advantages such as no pollution, no population resettlement, no fuel requirements, flexible construction, short construction schedules, and so on.

All eight of the wind powered generators in this phase of the project are equipment imported from Denmark at a total investment of 20 million yuan.

Inner Mongolia Completes Its Largest Solar Power Station

936B0055C Hohhot NEIMENGGU RIBAO in Chinese 17 Dec 92 p 2

[Article by reporter Xu Zhanqian [1776 2069 0467]: "Inner Mongolia's Largest Solar Power Station Completed at Abga—Much Illumination on the Prairie, Turning Desires Into Electricity"]

[Text] In the depth of winter, the heavy snow flew over Inner Mongolia's Abga prairie on the northern boundary of the motherland and the sky was white. I drove to Erdeng Gaobi Sumu (Township) to participate in a ceremony to mark the completion of the "Solar Powered Photoelectric Power Station" jointly established by the United Nations Planning and Development Office and the Chinese Government.

Erdeng Gaobi Sumu is located on the edge of central Inner Mongolia over 1,000 li from Hohhot. My colleague Xilin Gol League Science and Technology Commission chairman Buren [1580 0088] stated that this area is vast and sparsely populated, with an average of less than 1 person per square kilometers, so there is no way to supply electricity by relying on power grids. The pastoralists who live here have always used mutton oil and candles for illumination. The prairie is relatively rich in photoenergy resources with a total annual solar radiation value of 120 to 150 kilocalories per square centimeter and a daily illumination time of 2,800 to 3,200 hours. In the past, this photoenergy was never developed and utilized. Xilin Gol League imported capital from the United Nations Planning and Development Office in 1992 to import technology from the Gansu Provincial Academy of Sciences to establish this photoelectric station. This is the largest photoelectric station in Inner Mongolia and has ended the historical lack of electricity here.

Even though the temperature was minus 20 degrees, the bright and simple pastoral village was permeated with a warm and festive atmosphere as several 100 pastoralists from all four corners wearing their bright nationality clothing packed into the area around the photoelectric station. It was said that some of the pastoralists rode their horses through the snow from Hot (Village) several 10 li away to attend the celebration. After the ceremonies had begun, the Erdeng Gaobi Sumu CPC secretary, holding a pure white *hada* in his hands, lifted up a shining silver bowl in tribute toe two young engineers from the Gansu Provincial Academy of Sciences Natural Energy Institute, the persons with technical responsibility for the photoelectric station, and thanked the S&T workers for their months of arduous labor, praising them as "people who have brought light to the prairie".

At exactly 1000 hours in the morning, after the main switch of the power station was opened, the 120 pastoralist households simultaneously lit up with the fluorescent lamps that were fitted with electronic rectifiers and the videorecorders and big color televisions borrowed from the troops stationed nearby also became operating as the sonorous voice of general secretary Jiang Zemin's speech to the 14th CPC Central Committee resounded immediately over the snow-covered pastoral village. Cameras and videocameras flashed in alternation to record this unforgettable sight.

At the sumu cultural station, young men and women wearing Mongolian-style robes and colorful silk belts began dancing cheerfully. Pointing to this group of singing and dancing young people, S&T Sumu Dagrlemandeha said: "our economy has grown in the past 2 years, sumu cultural station and gacha (village) cultural offices have been established, and growing numbers of young pastoralists are coming to the cultural stations after work to read books and newspapers, banners and sumu have set up cultural stations, and there have been 'general knowledge of hygiene and sanitation lectures' and 'lectures on using scientific and technical knowledge to raise livestock,' but a lack of electricity affected these activities. Now we have the photoelectric station, and the problems are solved."

Surrounded by the singing and dancing masses, I struck up a conversation with the 64 year old pastoralist Taoketao. The elderly Taoketao was very happy as his television was finally dispatched to the site. He saw a television at a relative's house in 1991 and discovered that television played a major role in animal husbandry production: sometimes the windblown snow suddenly falls on the prairie and it is impossible for flocks of sheep to be herded back home, so they often freeze to death in groups, but the weather forecasts on TV could make it possible for him to avoid losses of hits cattle and sheep. "Moreover, selling livestock productions based on the conditions and information provided on television often lets me sell at a good price." He said he had sold two head of cattle and bought a 20-inch TV but the diesel generator used the generate electricity in his sumu was unable to supply the power, so he could only lock his TV up in a cabinet. Now, when he is sitting in his yurt he knows about changes in the weather and changes in market conditions.